WATER QUANTITY/QUALITY MONITORING PROGRAM

CUMBERLAND MARSHES PROJECT

1983 ANNUAL REPORT

Prepared by: Water Resources Branch of
Environment Canada in cooperation
with Ducks Unlimited, the Saskatchewan
Water Corporation and the Water Quality
Branch of Environment Canada

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Resource Management
Saskatchewan Water Corporation

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Environment Canada

Regina, Saskatchewan
1984-07-27

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Hydrology Branch
Water Management Service
Saskatchewan Environment

Water Quality Branch
Inland Waters Directorate
Environment Canada

Regina, Saskatchewan
1984 07 27

SYNOPSIS

The Cumberland Marshes water quantity/quality monitoring program was initiated in 1978 at the request of the Prairie Provinces Water Board (Minute 17-08 dated 1977 11 09). The program objectives are to collect surface water data that will produce a record of flow into and out of the project and determine trends in water quality and impacts, if any, on water quality that may be attributable to the Ducks Unlimited project. Water quantity data may also be used as an interpretive tool in the analysis of water quality trends.

The report covers water management and surface water monitoring activities in the Ducks Unlimited (Canada) Cumberland Marshes project for calendar year 1983.

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INTRODUCTION

This sixth annual report to the Prairie Provinces Water Board documents water management and surface water monitoring activities in the Ducks Unlimited (Canada) Cumberland Marshes Project for the calendar year 1983.

The location, monitoring points and structural details - natural and constructed channels, lakes, marshes and control works - are shown on the maps included with this report. The project area approximates a 1 300 km^2 rectangle bounded on the north by the Saskatchewan River Old Channel, on the east by the Manitoba-Saskatchewan boundary, on the south by Petabec Creek and the Birch River and on the west by the east boundaries of townships 55 and 56, range 6 west of the 2nd meridian. The area, a part of the Saskatchewan River delta, lies within a physiographic unit classified as the Cumberland Lake Lowland which forms part of the Manitoba Lowlands Region and is considered one of the outstanding wetland wildlife areas in North America.

Apart from the natural flow and storage regime, project water supplies may be augmented by regulated diversion from the Saskatchewan River Old Channel via the Dragline Channel to off-channel storage in Cut Beaver Lake. From Cut Beaver Lake, water may be routed to the various project lakes and marshes as required. Surplus water, riparian flows and supplies required for downstream use are delivered through and regulated by the Birch River Dam at the lower (east) end of the project and reach Manitoba via the Saskeram River.

Within the project, flows and water levels are regulated and adjusted by means of a complex system of natural and artificial channels, dykes and control structures. The project design is such that water levels within a number of management units can be regulated independently and within a time frame consistent with the objective of maximizing waterfowl and furbearer production by means of habitat improvement and maintenance.

The water quantity/quality monitoring program remained unchanged in 1983 and the network consisted of the following stations:

05KH011 Dragline Channel near Squaw Rapids
This station produces a twelve month record of flow into the project. A water quality sampling site is collocated here;

05KH014 Birch River Marsh near Cumberland House
This station produces a twelve month water level record. The record is in fact Birch River Dam headpond elevation and is used to compute regulated project releases to Manitoba via the Birch and Saskeram Rivers;

05KH013 Birch River near Manitoba Boundary
As a hydrometric station, this is a map location only at which flows are computed using the Birch River Marsh record and a schedule of gate operations at Birch River Dam. A water quality sampling site is collocated here.

DUCKS UNLIMITED (CANADA) OPERATIONS

Surface runoff in the Cumberland area in 1983 was below normal and spring surcharging of the Cumberland Marshes was less than in most years.

In 1983 the Dragline Channel was used to divert 19 400 dam^3 from the Saskatchewan River Old Channel to Cut Beaver lake. Inflow rates to Cut Beaver Lake were higher than specified by the Provincial Fisheries Branch as one bay of the inlet control structure froze open in November 1982 and remained open until the following February. These heavy flows resulted in a complete refill of the storage reservoir by spring break-up. Thus, the traditional refill operation which usually is completed during spring and summer was not required during 1983. Other major water management activities for 1983 are detailed below.

- Initial plans to begin the McGregor Lake drawdown in early May were revised to June 28 at the request of Manitoba Fisheries personnel involved with fish monitoring studies at the Bracken Dam. The drawdown was completed by August 31.

- The Birch River Marsh Centre was lowered during the summer to accept discharge and the adjacent unit was also lowered to prevent erosion along sections of the Birch River Marsh South Dyke.

- Retopping operations began on June 29 when the West Channel control structure was opened after fish screening nets were installed on the outlets of Cut Beaver Lake. Units retopped included Deep Lake, Bloodsucker Lake, Highbank Lake, Waterhen Lake, Egg Lake and West Wapisew Lake.

- Extremely hot and dry conditions during August and early September caused lake levels to fall by approximately 0.1 m and necessitated replacement of evapotranspiration losses from Cut Beaver Lake.

- Big, North McGregor and Bewley/Beaton lakes were partially refilled during August and September after temporary drainage. The latter unit was refilled to pass water into North McGregor Lake via Moosehorn Lake and was not relowered at the end of the season due to concerns about over-winter muskrat survival. Runoff and retopping will complete this refill during 1984.

- Fine-mesh screening nets were installed across the outlet between Cut Beaver Lake and downstream marsh units to prevent fish migration out of the reservoir. This operation was successful in restricting fish within the storage reservoir and will continue in 1984. Excellent fish survival was documented in this unit by test nettings in March and April, 1983. Local interest in fishing on Cut Beaver Lake has increased significantly in recent years.

- At the end of the 1983 operating season, all leaks between stop logs at the Cumberland Marshes Dam were sealed to prevent flow into the Birch River during the upcoming winter season. It is hoped that the absence of flow at the site will cause fish to disperse prior to freezeup thereby preventing fish die-offs below the dam this winter.

The 1983 water quantity monitoring and water quality sampling program designed by Environment Canada was completed by Ducks Unlimited (Canada) personnel. Thirteen discharge measurements and ten observations of zero flow were made at the Dragline Channel in addition to those made by Water Survey of Canada personnel. Twelve sets of water quality samples were collected at

the Dragline Channel and Birch River sites. A water level record and content changes for a number of project lakes are included in Appendix A.

WATER QUANTITY MONITORING

Operations During 1983

The water quantity monitoring program in the Ducks Unlimited Cumberland Marshes Project continued with no change in 1983. Hydrometric stations were operated throughout the year on the Dragline Channel and Birch River Marsh. Daily discharges for Birch River near Manitoba Boundary were computed for the entire year with gate leakage estimated when stoplogs were in place. Hydrometric data are given in Appendix A.

Good quality stage record was obtained at hydrometric station 05KH011 Dragline Channel near Squaw Rapids during the year. Water Survey of Canada personnel obtained nine measurements in addition to those made by Ducks Unlimited (Canada) staff. The quality of these measurements was considered to be good at low to medium flows and poor at very low flows. Because of problems with the control structure, beaver activity, weed growth, and repairs to the channel, the stage-discharge relation and hence the discharge record, is considered to be fair for this station. Four additional observations of zero flow were recorded by Water Survey of Canada staff.

The hydrometric station 05KH014 Birch River Marsh near Cumberland House was operated throughout the year. Degraded record was produced from March 9 to April 12. Missing record occurred from January 1 to 10 due to a pressure leak, July 13 to 21 due to recorder clock stoppage and December 8 to 28 due to a jammed pen carriage. The quality of record was considered as fair.

Daily discharges for the station 05KH013 Birch River near Manitoba Boundary were computed by Saskatchewan Environment based on the elevation of the Birch River Marsh and the stoplog operation of the outlet structure. Gate leakage was estimated at 0.015 m^3/s during the January 1 to October 16 period and

assumed to be zero after this latter date as leaks were sealed.

The 1983 hydrometric records produce the following crude project water inventory:

Volume diverted from Saskatchewan River Old Channel to project (recorded)	19 400 dam^3
Volume released from project to Manitoba (computed)	22 500 dam^3
Net storage computed from Ducks Unlimited project area	4 590 dam^3
Unrecorded (or unknown) project usage including conveyance and evaporative losses, unrecorded or unknown storage, groundwater recharge	-7 690 dam^3
Apparent project diversion	-3 100 dam^3

Actual project usage may be higher as no adjustment has been made for local inflow or direct increase in lake storage due to precipitation.

WATER QUALITY MONITORING

Introduction

A water quality monitoring program was initiated in the Cumberland Marshes during 1979. The objective of the program was to characterize the quality of the inflowing and outflowing waters of the Cumberland Marshes watershed to determine the possible effects of the project on exported water, and to document any water quality trends that may occur as the project reaches equilibrium. Sampling sites have been collocated with hydrometric stations at the Dragline Channel and the Birch River below Birch River Dam. The two sites are sampled twelve times yearly when access permits, according to flow-dependent sampling schedules.

Since initiation of the program, totals of fifty-one and forty-nine water quality samples have been collected from the Dragline Channel and Birch River sites, respectively. Twelve samples from each location were collected and analyzed during 1983. The results of eleven of those samples are included in this report. Analytical results for samples collected December 12, 1983 were not available at the time of publication. Sampling was done by Ducks Unlimited (Canada) personnel based near Cumberland House, and analyses were performed at the Water Quality Branch laboratories in Calgary, Saskatoon, and Burlington.

As mentioned in earlier reports, the controlled nature of water movement through the Cumberland Marshes complicates the interpretation of seasonal trends and intersite differences. During the open water season, waters entering the Dragline Channel can be routed into individual marshes to raise water levels, or can be moved directly through the system to the Birch River. As well, marsh drawdowns are performed periodically to enhance bottom and

shoreline growth for the improvement of waterfowl habitat. Thus, waters exiting the Marshes during the management season may have residence times of from several hours to several years. During the winter months, water movement through the system is minimal. Water quality during winter is therefore subject to localized effects not related to the dynamics of the system as a whole. Meaningful conclusions as to the water quality effects of various management practices in the Cumberland Marshes therefore require a substantial data base over a variety of flow regimes. A major review of the data collected during the period 1979 to 1984 will be undertaken in 1985.

Following is a discussion of the 1983 results together with an overview of water quality characteristics for the period 1979-1983. The water quality data from 1983 are presented in graphical and tabular form in Appendix B. Annual median results for the period 1979-1983 appear in Tables 1 and 2. Unless otherwise noted, concentrations referred to in the following discussions are annual median values.

Physical Parameters

The five physical parameters measured (pH, specific conductance, colour, turbidity, dissolved oxygen) showed sizeable differences between the two sites during the winter and spring periods. These differences were generally reduced during the summer and fall.

The waters of the Birch River showed consistent winter pH declines over the 1979 to 1982 period, with levels generally near a pH of 7.0. This occurred once again during 1983, with a low of pH 7.2 recorded during March. This decline is probably caused by the production of weak organic acids resulting from the decay of organic matter during the winter months. This conclusion is supported by the results for colour, which are relatively high at the Birch

Table 1 Median Results Dragline Channel Below WSC Control Structure

Parameter	1979	1980	1981	1982	1983
Dissolved Oxygen		10.1	9.0	12.0	9.0
pH (Lab)	8.1	8.2	8.2	8.2	8.0
Turbidity	3.4	3.9	2.5	2.8	3.0
Colour (App)	10.	20.	20.	20.	20.
Spec Cond (uS/cm)	437.	407.	404.	347.	415.
T.D.S.	232.	215.	215.	204.	242.
N.F.R.		5.	5.	6.	7.
Phosphorus Total	0.015	0.031	0.040	0.046	0.037
Nitrogen Total	0.39	0.48	0.50	0.49	0.47
Nitrogen Diss	0.29	0.36	0.42	0.41	0.33
Nitrogen Part	0.10	0.08	0.08	0.09	0.07
Nitrogen NO3 No2	0.04	0.12	0.17	0.25	0.02
Nitrogen NH4	<0.1		<0.1	<0.1	<0.1
Carbon Diss (mg	5.0	5.0	4.5	5.1	5.4
Carbon Part (mg	0.59	0.55	0.47	0.57	0.51
Chlorophyll 'a'	0.005	0.003	0.003	0.005	0.002
Phenolics (ug/L)	0.001	0.002	0.002	0.001	0.004
ColiForm Total		6.	9.	3.	5.5
ColiForm Fecal		2.	4.	3.	<2.
Alkalinity Total	130.	129.	137.	126.	155.
Alkalinity Phernol	0.0	0.0	0.0	0.0	0.0
Calcium	42.2	43.0	43.5	40.1	46.4
Magnesium	17.3	14.9	15.1	13.6	16.5
Total Hardness	177.	161.	171.	156.	188.
Bicarbonate	159.	157.	167.	154.	189.
Sulphate	65.	51.	46.	47.	47.
Chloride	7.4	7.8	6.4	6.8	9.8
Silica Reactive	1.5	1.7	2.0	2.1	2.8
Fluoride	0.13	0.13	0.15	0.15	0.12
Sodium	21.	18.	17.	15.	20.
Potassium	3.0	2.2	2.2	2.3	2.8
Arsenic (Diss.)	0.0007	0.0005	0.0008	0.0006	0.0007
Iron (Ext)	0.16	<0.04	0.11	0.12	0.17
Manganese (Ext)	0.02	<0.01	0.03	0.03	0.02
Copper (Total)	0.001	0.003	0.001	0.002	0.002
Lead (Total)	<0.004	<0.004	<0.004	<0.004	<0.004

Table 2 Median Results Birch River Below Birch River Dam

Parameter	1979	1980	1981	1982	1983
Dissolved Oxygen		9.3	7.4	9.6	9.0
pH (Lab)	7.8	7.9	8.0	7.6	7.7
Turbidity	1.4	3.5	2.4	1.4	2.5
Colour (App)	40.	50.	30.	40.	50.
Spec Cond (uS/cm)	551.	592.	668.	494.	606.
T.D.S.	277.	278.	319.	287.	325.
N.F.R.	1.5	6.	5.	2.	3.
Phosphorus Total	0.017	0.038	0.031	0.048	0.046
Nitrogen Total	0.76	1.1	1.1	0.66	1.0
Nitrogen Diss	0.68	1.0	0.74	0.57	0.89
Nitrogen Part	0.08	0.14	0.13	0.09	0.13
Nitrogen NO3-NO2	0.02	0.01	0.01	<0.01	0.01
Nitrogen NH3	<0.1		<0.1	<0.1	<0.1
Carbon Diss (mg	14.	17.	16.	12.	18.
Carbon Part (mg	0.40	0.90	0.83	0.64	0.79
Chlorophyll 'a'	0.003	0.002	0.004	0.004	0.004
Phenolics (ug/L)	0.001	0.002	0.003	0.002	0.007
ColiForm Total	6.	4.	<2.	3.	<2.
ColiForm Fecal	<2.	<2.	<2.	2.	<2.
Alkalinity Total	129.	147.	156.	165.	180.
Alkalinity Phernol	0.0	0.0	0.0	0.0	0.0
Calcium	46.8	46.0	55.7	45.9	43.1
Magnesium	18.7	19.9	24.2	19.0	22.4
Total Hardness	188.	191.	240.	183.	200.
Bicarbonate	157.	176.	190.	201.	219.
Sulphate	13.	11.	24.	12.	9.1
Chloride	71.	73.	86.	57.	75.5
Silica Reactive	4.3	2.2	2.3	2.5	8.8
Fluoride	0.11	0.11	0.14	0.14	0.13
Sodium	39.	42.	40.	36.	44.5
Potassium	4.0	4.3	5.4	5.4	5.3
Arsenic (Diss.)	0.0006	<.0005	0.0005	<.0005	0.0006
Iron (Ext)	0.35	<0.04	0.20	0.42	0.48
Manganese (Ext)	0.06	<0.01	0.05	0.05	0.14
Copper (Total)	<0.001	0.002	0.002	0.001	<0.001
Lead (Total)	<0.004	<0.004	<0.004	<0.004	<0.004

River site, especially during the winter period. Colour is greatly increased by the presence of tannins and lignins, even in low concentration. Reduced photosynthetic activity during the winter period can also cause pH declines, due to a reduction in the uptake of carbon dioxide by plants.

Turbidities were typically low and similar at the two locations during 1983, with the exception of the March sample at the Birch River site which had a turbidity of 25 NTU. Similar results were seen in non-filterable residue concentrations. There is some evidence of winter dissolved oxygen depletion at the Birch River site, with a concentration of 4.5 mg/L measured during January. This is likely caused by high under-ice oxygen demand produced by the reduction of organic materials. The data from 1979 to 1982 show evidence of winter oxygen shortages at this site as well.

Mean annual specific conductance during 1983 was approximately 30 percent higher at the Birch River than at the Dragline Channel. Higher specific conductance at the downstream site is to be expected due to evaporation, leaching of bottom sediment, and possible groundwater intrusion. The relative difference in specific conductance between sites was highest during the winter and spring months. The two locations had similar conductance during the late summer and fall. This is no doubt due to the variation in retention time of waters at different times of the year, and to the effects of localized dissolution during the low flow winter months. Trends in specific conductance and total dissolved solids (calculated) during 1983 were similar to those seen in previous years.

Major Ions

The relative abundance of ions at the two locations during 1983 was as follows (annual median values are used):

Cations

Dragline Channel: Ca (46.4) Na (20.) Mg (16.5) K (2.8)

Birch River: Na (44.5) Ca (43.1) Mg (22.4) K (5.3)

Anions

Dragline Channel: HCO3 (189.) SO4 (47.) Cl (9.8) SiO2 (2.8) F (.12)

Birch River: HCO3 (219.) Cl (75.5) SO4 (9.1) SiO2 (8.8) F (.13)

Waters in the Birch River show substantially higher sodium and chloride concentrations than at the Dragline Channel site, coupled with lower sulfate concentrations. These differences are sufficient to change the relative ionic orders for both cations and anions at the two sites. Possible explanations for the changing ionic abundances may be sulfate-chloride ion exchange, sodium chloride intrusion, and/or chemical precipitation of metallic sulfides.

While annual medians for bicarbonate and total hardness were similar at the two locations in 1983, the Birch River had concentrations substantially higher than the Dragline Channel during the January to July period, and concentrations somewhat lower than Dragline during August to October. In previous years, bicarbonate and total hardness concentations at the two locations have typically been near equivalence during the August to October period. This is the first time that Dragline Channel concentrations for these variables have exceeded those in the Birch River.

Silica (reactive) concentrations for the Birch River were higher (1983 median 8.8 mg/L) than in previous years (1979-82 median 3.0 mg/L). The years 1980-1982 showed spring and summer silica concentrations of less than 4. mg/L. During 1983 silica concentrations remained above 4. mg/L throughout the spring and summer period.

Nutrients and Biological Parameters

Median total phosphorous (TP) concentrations during 1983 were 0.037 mg/L at the Dragline Channel, and 0.046 mg/L at the Birch River. Highest TP concentrations at the Birch River occurred during the late winter, probably caused by the release of phosphorus from decaying organic matter. TP concentrations at the Dragline Channel were relatively consistent throughout the year, with a slightly elevated concentration during January.

Chlorophyll 'a' was present in relatively low concentration at the two sites during 1983. The highest concentration measured, 0.030 mg/L, was present in the May sample from the Birch River. During the period 1979-1982 the two sites had chlorophyll 'a' concentrations generally less than 0.010 mg/L, with occasional spikes to 0.020 mg/L.

Total nitrogen (TN) concentrations were consistently higher in the Birch River (median 1.0 mg/L) than in the Dragline Channel (median 0.47 mg/L). The majority of nitrogen present at both sites was in the dissolved form with a ratio of dissolved N:particulate N ranging from 5:1 to 8:1. Dissolved NO3-NO2 concentrations in the Birch River were very low during 1983, as was the case in previous years. It is probable that during the open water season, the majority of nitrate nitrogen is taken up to sustain plant growth in the Marshes. During the ice cover season, oxidized nitrogen forms are likely reduced to ammonia under anaerobic conditions. The ammonia data from 1983 give evidence that this reduction does in fact occur.

Carbon species have been found in generally higher concentration in the Birch River than in the Dragline Channel. Medians (1983) for dissolved organic carbon (DOC) were 5.4 mg/L and 18 mg/L at the Dragline Channel and Birch River stations, respectively, while particulate organic carbon (POC) measured 0.51 mg/L and 0.79 mg/L, respectively.

Coliforms (total and fecal) were present in low concentrations at the two monitoring locations during 1983. One exception was a sample taken on October 3 at the Birch River site, which had total and fecal coliform counts of 300 per 100 ml and 56 per 100 ml, respectively. Analysis of five of twelve coliform samples collected during 1983 was not possible due to excessive transportation delays.

Other Parameters

Iron (extractable) and manganese (extractable) increased to relatively high concentrations in the waters of the Birch River during the 1983 winter period. This seasonal trend also occurred during 1981 and 1982, and is probably caused by the release of iron or manganese hydroxides (or phosphates) during the anaerobic winter periods. Copper (total) and lead (total) were present at concentrations near or below detection limits at both stations during 1983.

Phenolic material was present in slightly higher concentration in the waters of the Birch River (median 0.007 ug/L) than in the Dragline Channel (median 0.004 ug/L) during 1983. Concentrations of phenolics were somewhat higher at both locations in 1983 than in previous years, when annual medians ranged from 0.001 ug/L to 0.003 ug/L at the two sites.

SUMMARY AND OBSERVATIONS

Water Quantity Monitoring

In 1983 a good quality stage record was obtained at 05KH011 Dragline Channel near Squaw Rapids and the intense flow metering program continued at this station. Interpretation of the record remained difficult, however, due to the poor stage-discharge relation. Equipment malfunction at 05KH014 Birch River Marsh near Cumberland House resulted in approximately two months of missing or degraded record but field coverage at this station by Ducks Unlimited (Canada) personnel has improved significantly. The quality of record was considered as fair. The computed record for 05KH013 Birch River near Manitoba Boundary was also considered to be fair. In spite of the 1982 recommendation that either Ducks Unlimited (Canada) or Saskatchewan Environment personnel obtain check measurements at this site each time stop logs are adjusted, this was not implemented. Water Survey of Canada personnel obtained check measurements at this station on two separate occasions but the results were not incorporated in station computations by Saskatchewan Environment.

During 1983:

- 19 400 dam^3 were diverted from the Saskatchewan River Old Channel to the Cumberland Marshes Project via the Dragline Channel.

- 22 500 dam^3 were released to Manitoba from the Cumberland Marshes Project via the Birch River Dam and Saskeram River.

- The net project storage reported by Ducks Unlimited (Canada) personnel was 4 590 dam^3. However, the crude water balance calculation for 1983 indicates that there was a net diversion to Manitoba of 3 100 dam^3. To balance the equation would require a project inflow from local runoff or direct increase in lake storage due to precipitation equivalent to 7 690 dam^3.

The magnitude of this term strongly suggests that significant errors are inherent in the water balance determination. These errors are related to the computation of inflow and outflow as well as to the estimation of project storage due to poorly defined stage-capacity relationships for the project lakes.

Water Quality Monitoring

The Dragline Channel and Birch River stations were sampled twelve times during 1983, with the majority of samples collected during the open water period. The water quality data base now extends over a four and one-half year period, from mid-1979 to the present.

This report presents the water quality results for 1983, and provides a brief discussion of water quality characteristics at the two monitoring locations during the period 1979 to 1983. An intensive review of water quality/quantity results for the period 1979 to 1984 will be undertaken during 1985 by the COWQ of the PPWB.

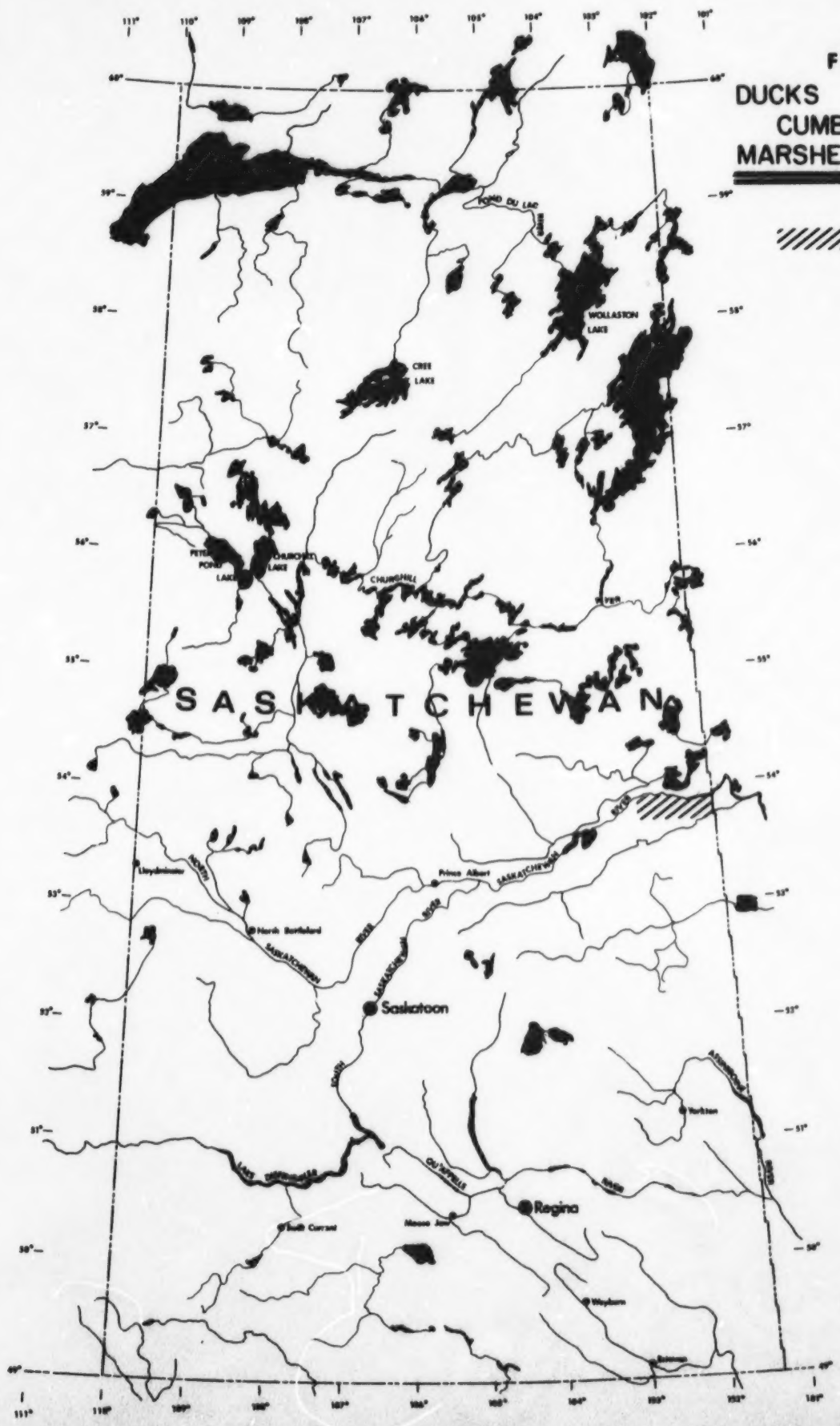
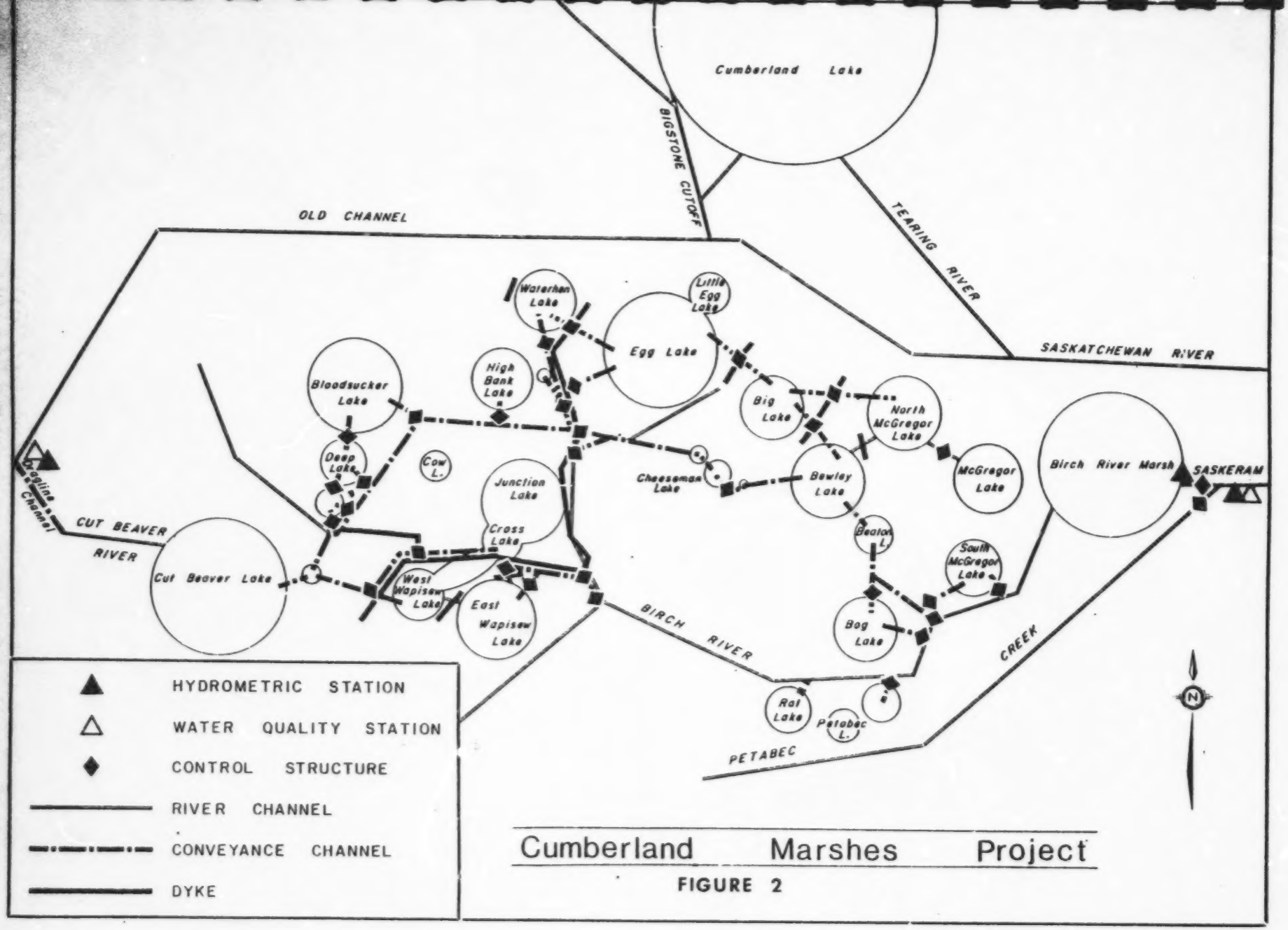


FIGURE 1

DUCKS UNLIMITED CUMBERLAND MARSHES PROJECT



Cumberland Marshes Project

FIGURE 2

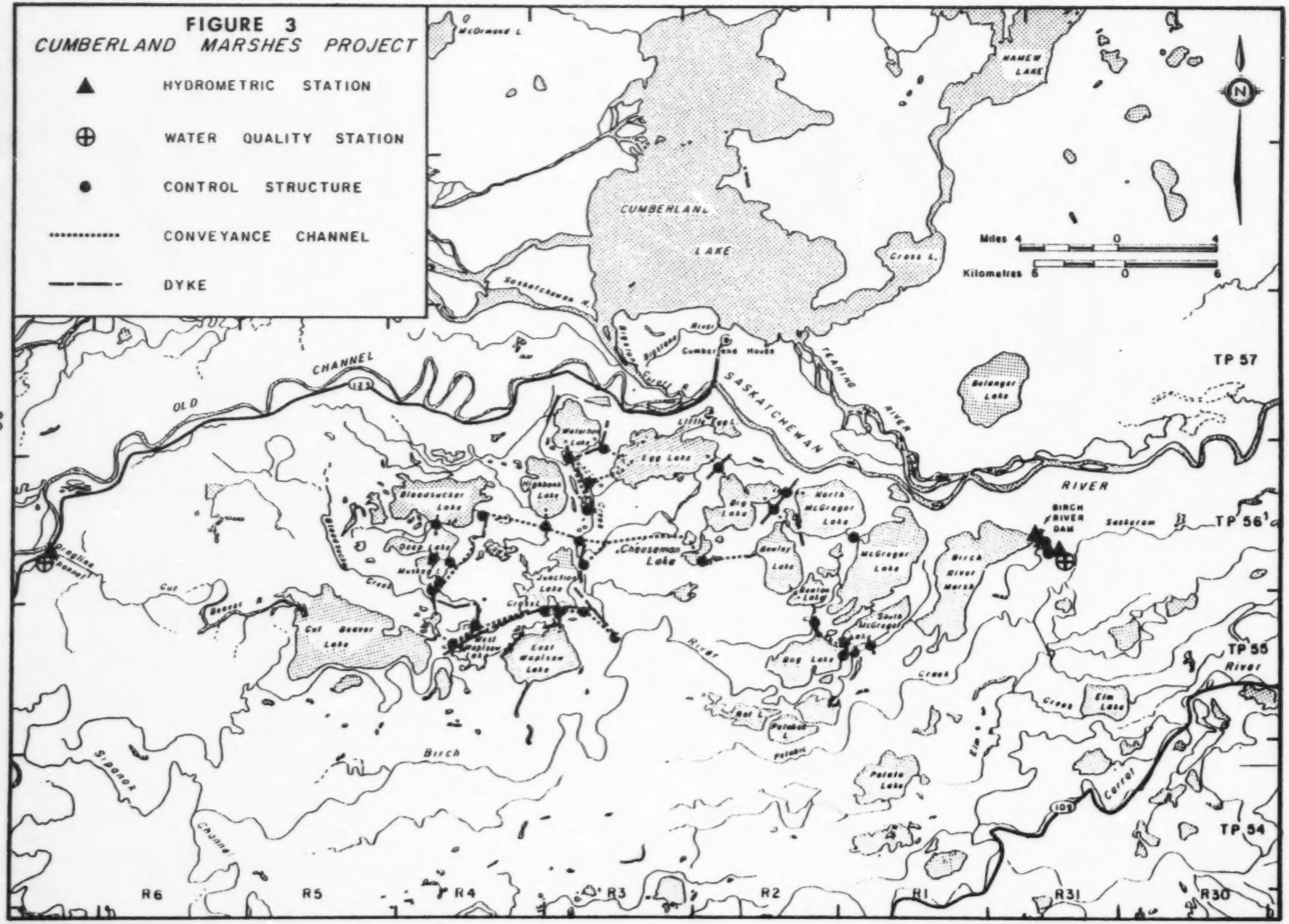


FIGURE 3
CUMBERLAND MARSHES PROJECT
HYDROMETRIC STATION
WATER QUALITY STATION
CONTROL STRUCTURE
CONVEYANCE CHANNEL
DYKE
CUMBERLAND LAKE
NAMEW LAKE
Cumberland House
SASKATCHEWAN RIVER
TEARING RIVER
CHANNEL
OLD
Bloodsucker Lake
Deep Lake
Cut Beaver Lake
Cut Beaver R.
Chesseman Lake
Big Lake
North McGregor Lake
McGregor Lake
Beaton Lake
South McGregor Lake
Bog Lake
Potato Lake
Elm Lake
BIRCH RIVER DAM
Birch River Marsh
Saskeram
TP 57
TP 56
TP 55
TP 54
R6
R5
R4
R3
R2
R1
R31
R30
Miles 4 0 4
Kilometres 6 0 6
N

APPENDIX A

[redacted] [redacted]R S[redacted]Y OF [redacted]ADA[redacted] [redacted] [redacted] [redacted] [redacted]RAG[redacted] CH[redacted] NE[redacted]QUA[redacted]IDS[redacted] [redacted] [redacted] [redacted] ST[redacted]N NO[redacted]KHO[redacted]

MAY 14 1984
REGINA, SASK.

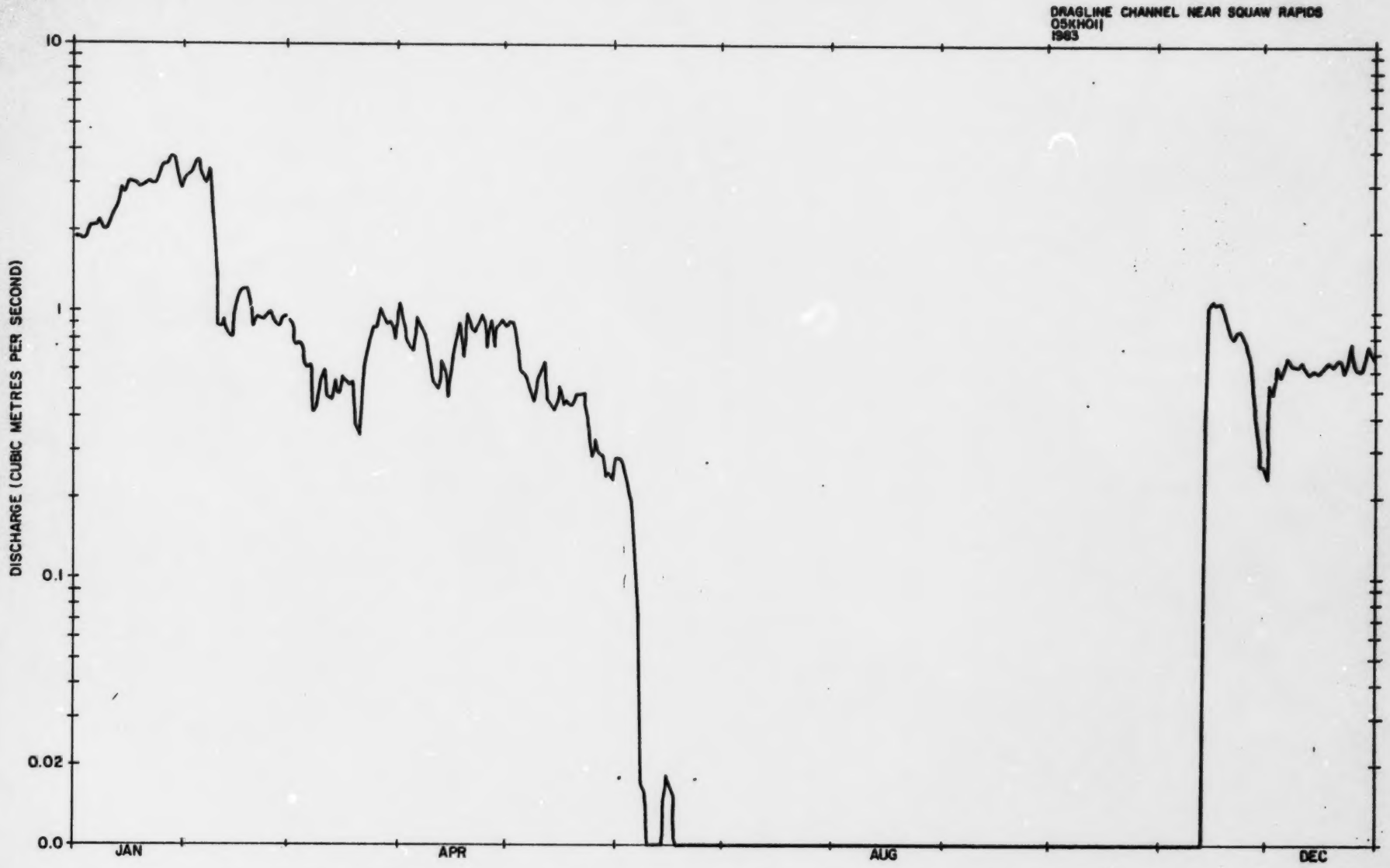
DAILY DISCHARGE IN CUBIC METRES PER SECOND FOR 1983

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DAY
1	1.90 B	3.26 B	0.919 B	0.961 B	0.917 B	0.287	0	0	0	0	0	0.533 B	1
2	1.85 B	3.46 B	0.741 B	0.794 B	0.910 B	0.277	0	0	0	0	0	0.483 B	2
3	1.88 B	3.69 B	0.765 B	0.741 B	0.758	0.244	0	0	0	0	0	0.632 B	3
4	2.08 B	3.75 B	0.731 B	0.706 B	0.608	0.204	0	0	0	0	0	0.571 B	4
5	2.10 B	3.21 B	0.616 B	0.957 B	0.589	0.129	0	0	0	0	0	0.630 B	5
6	2.06 B	3.00 B	0.631 B	0.892 B	0.561	0.075	0	0	0	0	0	0.681 B	6
7	2.23 B	3.49 B	0.416 B	0.830 B	0.507	0.017	0	0	0	0	0	0.651 B	7
8	2.03 B	2.43 B	0.451 B	0.755 B	0.454	0.012	0	0	0	0	0	0.627 B	8
9	2.04 B	0.881 B	0.540 B	0.635 B	0.551	0	0	0	0	0	0	0.625 B	9
10	2.16 B	0.882 B	0.617 B	0.546 B	0.613	0	0	0	0	0	0 B	0.651 B	10
11	2.38 B	0.949 B	0.475 B	0.505 B	0.643	0	0	0	0	0	0 B	0.600 B	11
12	2.50 B	0.828 B	0.466 B	0.658 B	0.473	0	0	0	0	0	0 B	0.582 B	12
13	2.94 B	0.790 B	0.560 B	0.611 B	0.446	0	0	0	0	0	0.500 B	0.609 B	13
14	2.78 B	0.952 B	0.486 B	0.474 B	0.424	0.018	0	0	0	0	1.05 B	0.603 B	14
15	3.10 B	1.15 B	0.577 B	0.624 B	0.531	0.016	0	0	0	0	1.11 B	0.593 B	15
16	3.04 B	1.23 B	0.555 B	0.734 B	0.450	0.013	0	0	0	0	1.07 B	0.615 B	16
17	3.01 B	1.25 B	0.528 B	0.916 B	0.469	0	0	0	0	0	1.08 B	0.657 B	17
18	2.90 B	1.10 B	0.546 B	0.663 B	0.448	0	0	0	0	0	1.07 B	0.642 B	18
19	2.97 B	0.866 B	0.384 B	0.993 B	0.462	0	0	0	0	0	0.903 B	0.628 B	19
20	3.01 B	0.969 B	0.337 B	0.874 B	0.497	0	0	0	0	0	0.844 B	0.667 B	20
21	3.10 B	0.936 B	0.596 B	0.830 B	0.497	0	0	0	0	0	0.798 B	0.665 B	21
22	3.01 B	0.924 B	0.678 B	0.905 B	0.502	0	0	0	0	0	0.851 B	0.588 B	22
23	2.99 B	0.997 B	0.763 B	0.979 B	0.377	0	0	0	0	0	0.864 B	0.640 B	23
24	3.31 B	1.01 B	0.893 B	0.915 B	0.284	0	0	0	0	0	0.777 B	0.773 B	24
25	3.58 B	0.917 B	0.880 B	0.733 B	0.337	0	0	0	0	0	0.692 B	0.643 B	25
26	3.58 B	0.866 B	1.03 B	0.932 B	0.299	0	0	0	0	0	0.606 B	0.599 B	26
27	3.85 B	0.918 B	0.922 B	0.729 B	0.287	0	0	0	0	0	0.430 B	0.603 B	27
28	3.82 B	0.966 B	0.897 B	0.894 B	0.242	0	0	0	0	0	0.264 B	0.660 B	28
29	3.43 B		0.920 B	0.943 B	0.250	0	0	0	0	0	0.260 B	0.746 B	29
30	2.88 B		0.777 B	0.880 B	0.236	0	0	0	0	0	0.236 B	0.690 B	30
31	3.13 B		1.07 B		0.287		0	0		0		0.627 B	31
TOTAL	85.64	45.671	20.767	23.609	14.909	1.292	0	0	0	0	13.405	19.514	TOTAL
MEAN	2.76	1.63	0.670	0.787	0.481	0.043	0	0	0	0	0.447	0.629	MEAN
DAM3	7400	3950	1790	2040	1290	112	0	0	0	0	1160	1690	DAM3
MAX	3.85	3.75	1.07	0.993	0.917	0.287	0	0	0	0	1.11	0.773	MAX
MIN	1.85	0.790	0.337	0.474	0.236	0	0	0	0	0	0	0.483	MIN

SUMMARY FOR THE MONTHS JAN TO DEC
MEAN DISCHARGE, 0.616 M3/S
TOTAL DISCHARGE, 19400 DAM3
MAXIMUM DAILY DISCHARGE, 3.85 M3/S ON JAN 27
MINIMUM DAILY DISCHARGE, 0 M3/S ON JUN 9

MAXIMUM INSTANTANEOUS DISCHARGE, 4.29 "B" M3/S AT 0436 CST ON FEBRUARY 4 1983

B-ICE CONDITIONS


DRAGLINE CHANNEL NEAR SQUAW RAPIDS
05KH011
1983
DISCHARGE (CUBIC METRES PER SECOND)
10
1
0.1
0.02
0.0
JAN
APR
AUG
DEC

22

(22)

[redacted] [redacted]R S[redacted]Y O[redacted]ADA[redacted] [redacted] [redacted] [redacted]BIRC[redacted]VER[redacted]SH [redacted]CUM[redacted]AND[redacted]E [redacted] [redacted] [redacted] STATION N[redacted]5KH[redacted]

MAY 14 1984
REGINA, SASK.

DAILY WATER LEVEL IN METRES FOR 1983

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DAY
1	263.950 E	264.039	263.948	263.857 A	264.024	263.987	263.967	263.747	263.304	263.618	263.734	263.803	1
2	263.955 E	264.034	263.947	263.851 A	264.027	263.984	263.971	263.716	263.321	263.616	263.729	263.804	2
3	263.962 E	264.032	263.941	263.850 A	264.027	263.990	263.978	263.645	263.348	263.620	263.733	263.810	3
4	263.968 E	264.030	263.941	263.850 A	264.028	263.996	263.985	263.628	263.352	263.628	263.741	263.814	4
5	263.974 E	264.024	263.940	263.849 A	264.029	263.995	263.979	263.616	263.363	263.638	263.752	263.818 A	5
6	263.980 E	264.022	263.938	263.854 A	264.030	263.991	263.968	263.606	263.388	263.637	263.746	263.819	6
7	263.985 E	264.019	263.943	263.871 A	264.027	263.987	263.949	263.599	263.403	263.641	263.755	263.824	7
8	263.993 E	264.009	263.939	263.888 A	264.026	263.988	263.934	263.587	263.415	263.644	263.763	263.825 A	8
9	264.000 E	264.007	263.933 A	263.900 A	264.022	263.982	263.921	263.560	263.421	263.645	263.762	263.829 E	9
10	264.006 A	264.007	263.933 A	263.910 A	264.014	263.984	263.913	263.553	263.456	263.652	263.761	263.831 E	10
11	264.011	264.005	263.931 A	263.921 A	264.027	263.980	263.906	263.546	263.469	263.665	263.762	263.833 E	11
12	264.012	264.001	263.927 A	263.930 A	264.036	263.984	263.892 A	263.509	263.478	263.669	263.767	263.835 E	12
13	264.020	264.002	263.924 A	263.932	264.033	264.008	263.890 A	263.458	263.492	263.675	263.770	263.838 E	13
14	264.024	263.997	263.918 A	263.931	264.036	264.011	263.880 E	263.438	263.500	263.679	263.771	263.840 E	14
15	264.024	263.993	263.912 A	263.929	264.040	264.017	263.872 E	263.432	263.508	263.681	263.770	263.842 E	15
16	264.026	263.991	263.911 A	263.927	264.046	264.022	263.862 E	263.413	263.514	263.690	263.767	263.845 E	16
17	264.022	263.983	263.908 A	263.926	264.042	264.019	263.852 E	263.405	263.525	263.691	263.766	263.848 E	17
18	264.026	263.979	263.904 A	263.937	264.034	264.013	263.842 E	263.392	263.562	263.688	263.769	263.850 E	18
19	264.031	263.975	263.903 A	263.969	264.021	264.012	263.835 E	263.393	263.562	263.688	263.772	263.852 E	19
20	264.032	263.972	263.897 A	263.993	264.017	264.009	263.828 E	263.376	263.565	263.698	263.772	263.855 E	20
21	264.036	263.972	263.892 A	264.011	264.023	264.008	263.824 A	263.360	263.568	263.708	263.772	263.858 E	21
22	264.039	263.973	263.888 A	264.019	264.031	264.001	263.802	263.341	263.572	263.708	263.771	263.860 E	22
23	264.041	263.969	263.882 A	264.020	264.024	263.998	263.795	263.328	263.582	263.719	263.773	263.865 E	23
24	264.040	263.962	263.883 A	264.020	264.021	263.993	263.789	263.319	263.588	263.721	263.778	263.870 E	24
25	264.033	263.962	263.883 A	264.018	264.013	263.993	263.782	263.312	263.593	263.719	263.781	263.874 E	25
26	264.034 A	263.962	263.878 A	264.021	264.014	264.002	263.777	263.305	263.590	263.720	263.784	263.878 E	26
27	264.035	263.953	263.874 A	264.020	264.014	264.008	263.766	263.300	263.599	263.727	263.784	263.880 E	27
28	264.044	263.950	263.870 A	264.018	264.005	263.989	263.759	263.291	263.606	263.728	263.783	263.883 A	28
29	264.045		263.867 A	264.021	263.995	263.951	263.755	263.281	263.607	263.727	263.792	263.885	29
30	264.039		263.863 A	264.025	263.994	263.961	263.757	263.273	263.610	263.729	263.800	263.886	30
31	264.040		263.861 A		263.993		263.754	263.277		263.732		263.885	31
TOTAL	8184.427	7391.824	8181.179	7918.268	8184.713	7919.863	8179.784	8167.006	7904.861	8174.101	7912.980	8179.239	TOTAL
MEAN	264.014	263.994	263.909	263.942	264.023	263.995	263.864	263.452	263.495	263.681	263.766	263.846	MEAN
MAX	264.045	264.039	263.948	264.025	264.046	264.022	263.985	263.747	263.610	263.732	263.800	263.886	MAX
MIN	263.950	263.950	263.861	263.849	263.993	263.951	263.754	263.273	263.304	263.616	263.729	263.803	MIN

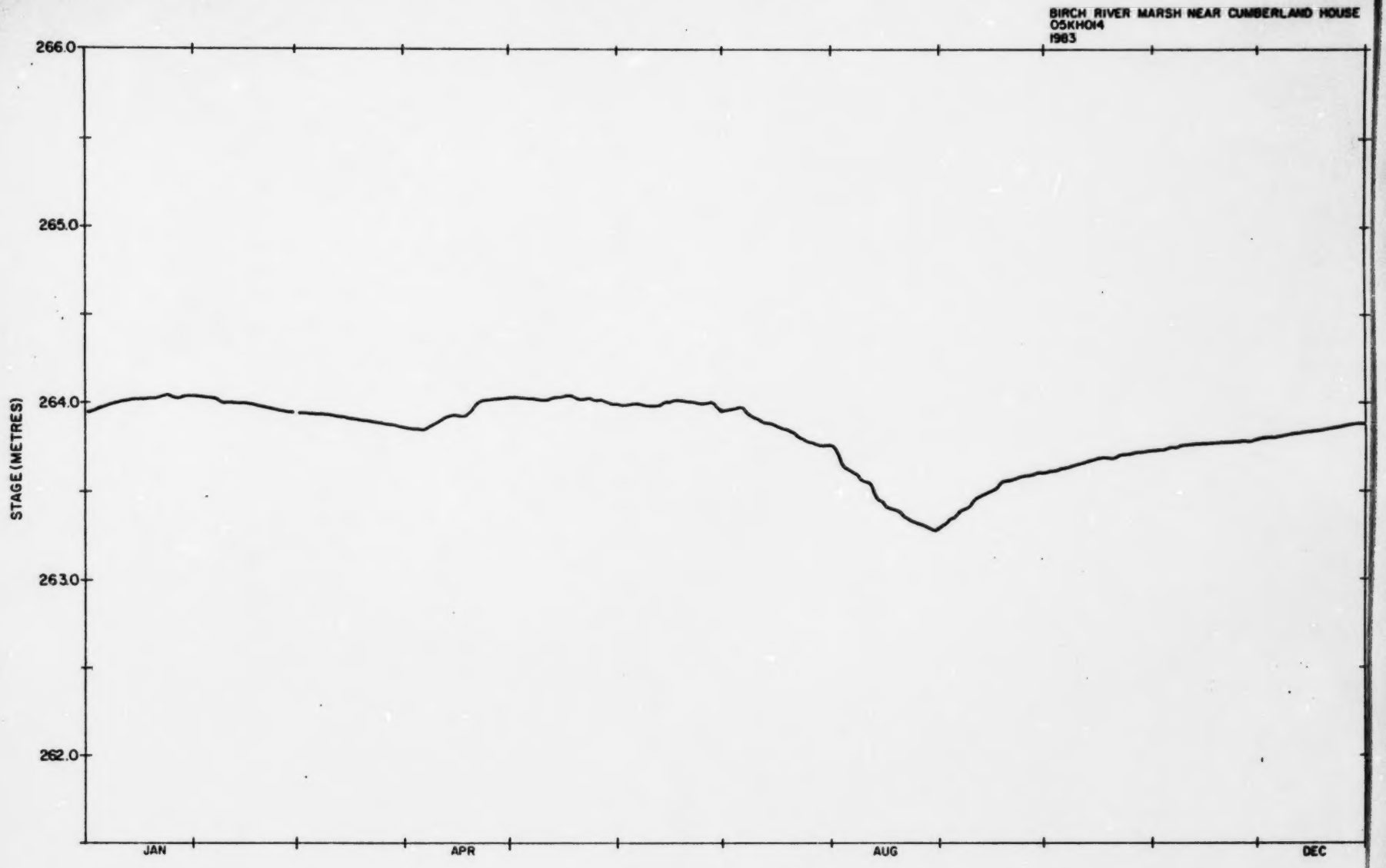
SUMMARY FOR THE YEAR 1983

MAXIMUM DAILY WATER LEVEL, 264.046 METRES ON MAY 16

MINIMUM DAILY WATER LEVEL, 263.273 METRES ON AUG 30
MAXIMUM INSTANTANEOUS WATER LEVEL, 264.051 METRES AT 1954 CST ON MAY 16 1983
WATER LEVELS ARE REFERRED TO GEODETIC SURVEY OF CANADA DATUM

A-MANUAL GAUGE

E-ESTIMATED


BIRCH RIVER MARSH NEAR CUMBERLAND HOUSE
05KH014
1983
266.0
265.0
264.0
263.0
262.0
STAGE (METRES)
JAN
APR
AUG
DEC

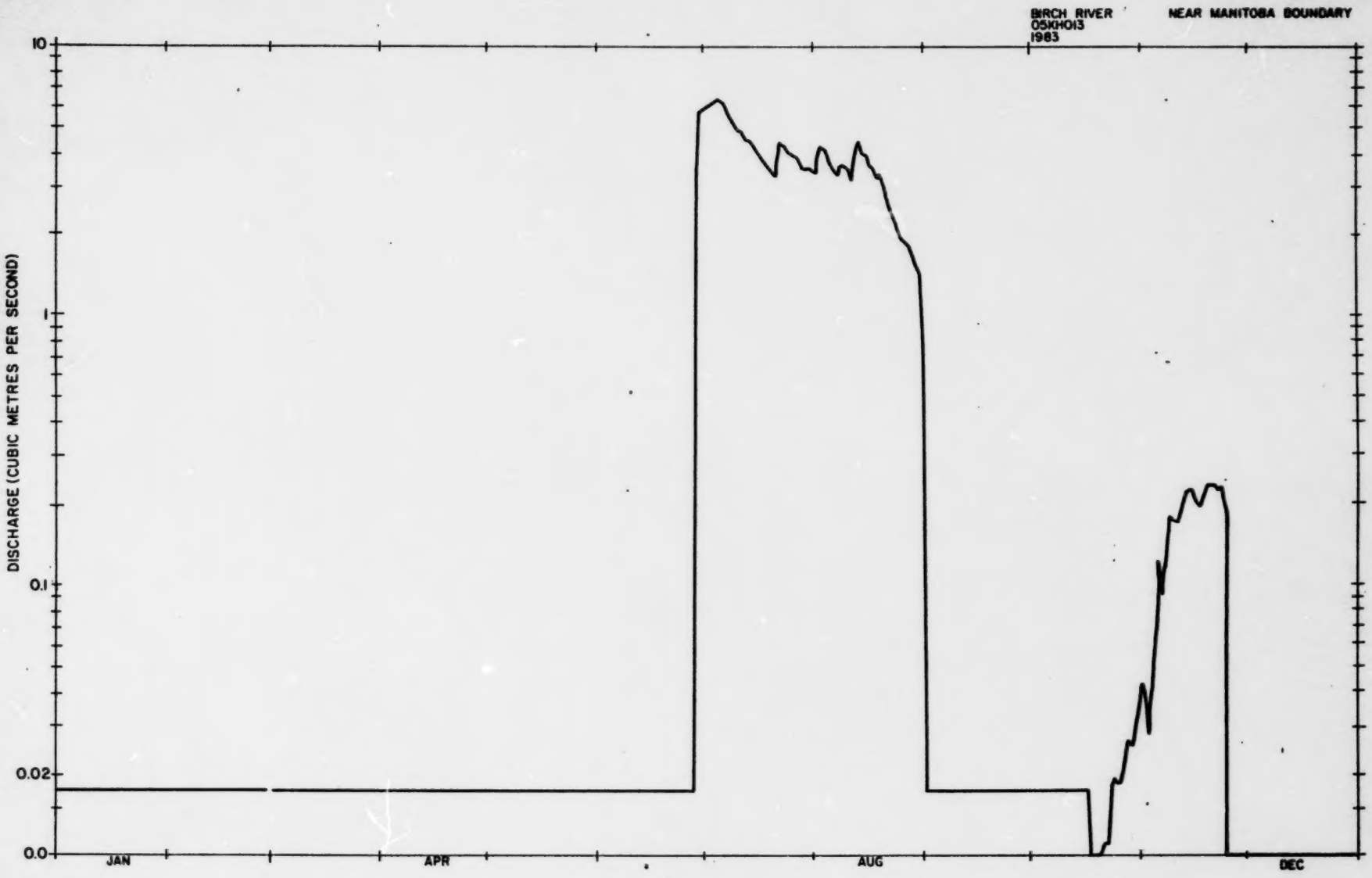
[redacted] BIRC[redacted]VER[redacted]R MA[redacted]B A[redacted]NDAR[redacted] [redacted] [redacted] [redacted] ST[redacted]N NO[redacted]SJHO[redacted]

DAILY DISCHARGE IN CUBIC METRES PER SECOND FOR 1983

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DAY
1	0.015 B	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	6.12	3.40	0.015 E	0.015 E	0.044	0 B	1
2	0.015 B	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	6.20	4.28	0.015 E	0.015 E	0.028	0 B	2
3	0.015 B	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	6.34	4.24	0.015 E	0.015 E	0.039	0 B	3
4	0.015 B	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	6.50	3.92	0.015 E	0.015 E	0.066	0 B	4
5	0.015 B	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	6.38	3.68	0.015 E	0.015 E	0.121	0 B	5
6	0.015 B	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	6.14	3.50	0.015 E	0.015 E	0.092	0 B	6
7	0.015 B	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	5.70	3.38	0.015 E	0.015 E	0.138	0 B	7
8	0.015 B	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	5.40	3.70	0.015 E	0.015 E	0.181	0 B	8
9	0.015 B	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	5.14	3.68	0.015 E	0.015 E	0.176	0 B	9
10	0.015 B	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	4.90	3.52	0.015 E	0.015 E	0.171 B	0 B	10
11	0.015 B	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	4.84	3.24	0.015 E	0.015 E	0.176 B	0 B	11
12	0.015 B	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	4.56	4.20	0.015 E	0.015 E	0.204 B	0 B	12
13	0.015 B	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	4.50	4.56	0.015 E	0.015 E	0.222 B	0 B	13
14	0.015 B	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	4.30	4.16	0.015 E	0.015 E	0.229 B	0 B	14
15	0.015 B	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	4.16	4.04	0.015 E	0.015 E	0.222 B	0 B	15
16	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	0.015 E	3.98	3.68	0.015 E	0.015 E	0.204 B	0 B	16
17	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	0.015 E	3.80	3.54	0.015 E	0	0.199 B	0 B	17
18	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	0.015 E	3.60	3.30	0.015 E	0	0.216 B	0 B	18
19	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	0.015 E	3.48	3.32	0.015 E	0	0.236 B	0 B	19
20	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	0.015 E	3.34	3.02	0.015 E	0	0.236 B	0 B	20
21	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	0.015 E	4.10	2.74	0.015 E	0.002	0.236 B	0 B	21
22	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	0.015 E	4.42	2.44	0.015 E	0.002	0.229 B	0 B	22
23	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	0.015 E	4.30	2.24	0.015 E	0.017	0.231 B	0 B	23
24	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	0.015 E	4.16	2.10	0.015 E	0.019	0.185 B	0 B	24
25	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	0.015 E	4.02	1.98	0.015 E	0.017	0 B	0 B	25
26	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	0.015 E	3.94	1.88	0.015 E	0.018	0 B	0 B	26
27	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	0.015 E	3.72	1.82	0.015 E	0.026	0 B	0 B	27
28	0.015 B	0.015 B	0.015 B	0.015 E	0.015 E	3.50 E	3.60	1.68	0.015 E	0.027	0 B	0 B	28
29	0.015 B		0.015 B	0.015 E	0.015 E	5.76	3.54	1.54	0.015 E	0.026	0 B	0 B	29
30	0.015 B		0.015 B	0.015 E	0.015 E	5.98	3.58	1.46	0.015 E	0.029	0 B	0 B	30
31	0.015 B		0.015 B		0.015 E		3.52	0.750		0.036		0 B	31
TOTAL	0.465	0.420	0.465	0.450	0.465	15.645	142.28	94.990	0.450	0.459	4.081	0	TOTAL
MEAN	0.015	0.015	0.015	0.015	0.015	0.522	4.59	3.06	0.015	0.015	0.136	0	MEAN
DAM3	40.2	36.3	40.2	38.9	40.2	1350	12300	8210	38.9	39.7	353	0	DAM3
MAX	0.015	0.015	0.015	0.015	0.015	5.98	6.50	4.56	0.015	0.036	0.236	0	MAX
MIN	0.015	0.015	0.015	0.015	0.015	0.015	3.34	0.750	0.015	0	0	0	MIN

SUMMARY FOR THE MONTHS JAN TO DEC
MEAN DISCHARGE, 0.713 M3/S
TOTAL DISCHARGE, 22500 DAM3
MAXIMUM DAILY DISCHARGE, 6.50 M3/S ON JUL 4
MINIMUM DAILY DISCHARGE, 0 M3/S ON OCT 17

B-ICE CONDITIONS
E-ESTIMATED


BIRCH RIVER
05KH013
1983
NEAR MANITOBA BOUNDARY
DISCHARGE (CUBIC METRES PER SECOND)
10
1
0.1
0.02
0.0
JAN
APR
AUG
DEC

PROJECT LAKE RECORDS 1983

LAKE	ELEVATION (m) Oct 8/82	ELEVATION (m) Sept 27/83	VARIATION (m)	VOLUME (dam^3)
Bewley/Beaton	264.32	264.51	+0.19	+2 290
Big	263.93	264.54	+0.61	+4 480
Birch River Marsh	263.68	263.50	-0.18	-925
Birch River Marsh North	263.71	263.90	+0.19	+2 040
Birch River Marsh South	263.65	263.74	+0.09	+470
Bloodsucker	266.58	266.70	+0.12	+2 070
Bog	264.02	264.23	+0.21	+1 990
Cut Beaver	267.52	267.43	-0.09	-4 510
Deep	266.94	266.97	+0.03	+190
Egg	265.85	266.03	+0.18	+4 220
Highbank	266.49	266.64	+0.15	+1 180
Junction Flats	266.58	266.58	same	no change
Junction	267.04	267.04	same	no change
McGregor	264.32	263.65	-0.67	-15 410
North McGregor	264.17	264.35	+0.18	+2 070
Muskeg	267.25	267.31	+0.06	+100
Rat/Petabecs	264.11	264.38	+0.27	+2 820
Waterhen	266.43	266.46	+0.03	+220
East Wapisew	266.09	266.24	+0.15	+2 100
West Wapisew	266.64	266.55	-0.09	-810

NET CHANGE IN INTERNAL STORAGE = +4 590 dam^3

APPENDIX B

PROJECT: 0487A51

DUCKS UNLIMITED CUMBERLAND MARSHES

WATER QUALITY PROGRAM

SAMPLING LOCATIONS:	NAQUADAT NUMBER
(1) Birch River below Cumberland Marshes Dam	00SA05KH0004
(2) Dragline Channel below control structure	00SA05KH0003

SAMPLING FREQUENCY: 12 times per year

PARAMETERS:

Group

A Physical Parameters

pH (field and lab)	Conductivity (field and lab)
Turbidity	Dissolved Oxygen (field)
Colour	Temperature (field and lab)

B Biological Parameters

Total Coliforms
Fecal Coliforms
Chlorophyll 'A'

C Major Ions and Calculated Parameters

Alkalinity P	Sulfate
Alkalinity T	Carbonate
Calcium	Bicarbonate
Chloride	Hardness (calculated)
Fluoride	Sum of Constituents
Magnesium	
Potassium	
Silica	
Sodium	

D Nutrients

Dissolved Organic Carbon	$NO_3 + NO_2$
Particulate Organic Carbon	Ammonia
Dissolved Nitrogen	Total Nitrogen (calculated)
Particulate Nitrogen	Total Phosphorus

E Metals

Copper (Total)	Iron (extractable)
Manganese (extractable)	Lead (Total)

F Miscellaneous

Phenols	Arsenic (dissolved)
NFR	

1983 Results - Dragline Channel Below WSC Control Structure

Date	Oxygen Diss.	pH Lab	pH Field	Spec Cond (L)	Spec Cond (F)	Turb Lab	Colour Appar
10-JAN-83	13.9	7.9		441		1.5	20
07-MAR-83	8.6	7.8		405		2.2	20
16-MAY-83	12.3	8.0	8.2	359	283	6.4	30
06-JUN-83	10.6	8.0	8.4	392	370	3.0	20
27-JUN-83	8.4	8.0		406	369	6.5	20
18-JUL-83	7.8	8.1	8.2	386	375	2.7	30
08-AUG-83	6.7	8.0		415	419	1.6	30
15-AUG-83	12.9	8.4	7.6	457	480	2.0	20
12-SEP-83	7.5	7.6	7.4	523	429	5.4	30
03-OCT-83	13.0	7.7		528	405	5.0	30
16-OCT-83	9.0	7.7		470		4.0	10
12-DEC-83							

Date	Temp Lab	Temp Field	T.D.S. Calc	N.F.R. 105 C.	P Total	N Total	N Diss
10-JAN-83	11.5	1.0	271	3	0.150	0.51	0.45
07-MAR-83	19.3	0.5	242	3	0.037	0.54	0.51
16-MAY-83	23.2	1.0	200	7	0.045		
06-JUN-83	22.4	12.0	213	6	0.056		
27-JUN-83	19.9	17.0	222	9	0.032	0.47	0.33
18-JUL-83	16.6	19.0	211	3	0.030	0.27	0.25
08-AUG-83	26.0	21.0	233	4	0.022	0.34	0.31
15-AUG-83	21.4	15.0	264	9	0.027	0.36	0.29
12-SEP-83	21.9	19.0	301	10	0.036	0.40	0.31
03-OCT-83	17.2	7.0	303	10	0.047	0.63	0.39
16-OCT-83	17.9	4.5	270	9	0.047	0.56	0.37
12-DEC-83							

Date	N Part	N NO23	N NH3	C DissOrg	C PartOrg	Chlor a
10-JAN-83	0.06	0.170	0.05	4.4	0.72	0.0200
07-MAR-83	0.03	0.350	0.05	3.0	0.20	0.0010
16-MAY-83			0.05			0.0100
06-JUN-83			0.05			0.0060
27-JUN-83	0.14	0.020	0.05	5.3	0.90	0.0020
18-JUL-83	0.02	0.060	0.05	5.0	0.15	0.0010
08-AUG-83	0.03	0.030	0.05	5.4	0.17	0.0010
15-AUG-83	0.07	0.005	0.05	6.5	0.45	0.0010
12-SEP-83	0.09	0.010	0.05	5.7	0.51	0.0020
03-OCT-83	0.24	0.005	0.05	7.0	1.20	0.0020
16-OCT-83	0.19	0.010	0.05	6.9	1.00	0.0005
12-DEC-83						

Date	Phenol ug/l	Coli-T	Coli-F	Alk-T	Alk-P	Ca	Mg
10-JAN-03	0.0020	40	1	175	0	52.3	17.4
07-MAR-03	0.0005	10	1	155	0	48.1	16.5
16-MAY-03	0.0020	1	1	125	0	37.1	12.8
06-JUN-03	0.0040	1	1	140	0	40.8	14.5
27-JUN-03	0.0040	1	1	145	0	42.1	14.8
18-JUL-03	0.0040			135	0	41.9	15.1
08-AUG-03				140	0	42.0	15.8
15-AUG-03	0.0070			175	0	46.4	19.4
12-SEP-03	0.0020			225	0	58.7	22.3
03-OCT-03	0.0040	40	20	220	0	57.6	22.0
16-OCT-03	0.0070			170	0	47.9	17.6
12-DEC-03							

Date	T-Hard Calc	Bicarb Calc	SO4	Cl	SiO2	F	Na	K
10-JAN-03	202	213	59	10.0	1.6	0.15	22	2.8
07-MAR-03	188	189	52	6.8	3.4	0.08	18	2.3
16-MAY-03	145	152	46	6.7	3.6	0.09	16	2.7
06-JUN-03	162	171	42	9.3	1.2	0.16	18	2.8
27-JUN-03	166	177	44	9.8	2.2	0.11	19	2.6
18-JUL-03	167	165	47	6.3	1.8	0.12	15	2.3
08-AUG-03	170	171	57	7.8	2.9	0.13	20	2.7
15-AUG-03	196	213	53	11.0	3.1	0.18	23	3.0
12-SEP-03	238	274	41	13.0	3.9	0.11	24	3.1
03-OCT-03	234	268	47	12.0	2.2	0.11	26	3.7
16-OCT-03	192	207	55	14.0	2.8	0.16	27	3.1
12-DEC-03								

Date	Arsenic Diss	Iron Ext	Mn Ext	Copper Total	Lead Total
10-JAN-03	0.00050	0.05	0.020	0.001	0.002
07-MAR-03	0.00070	0.02	0.010	0.002	0.002
16-MAY-03	0.00050	0.16	0.020	0.002	0.002
06-JUN-03	0.00025	0.17	0.080	0.002	0.002
27-JUN-03	0.00070	0.31	0.100	0.002	0.002
18-JUL-03	0.00090	0.18	0.020	0.001	0.002
08-AUG-03	0.00130	0.17	0.070	0.001	0.002
15-AUG-03					
12-SEP-03	0.00250			0.002	0.002
03-OCT-03	0.00060	0.65	0.170	0.003	0.002
16-OCT-03	0.00200	0.02	0.005	0.002	0.002
12-DEC-03					

1983 Results - Birch River Below Birch River Dam

Date	Oxygen Diss.	pH Lab	pH Field	Spec Cond (L)	Spec Cond (F)	Turb Lab	Colour Appar
10-JAN-83	4.5	7.3	6.8	585		2.2	30
07-MAR-83	8.3	7.2		927		25.0	240
16-MAY-83	11.0	7.6	7.8	870	620	7.8	50
06-JUN-83	9.0	7.7	8.1	807		3.0	60
27-JUN-83	11.0	8.1	8.0	728	695	3.0	60
18-JUL-83	9.0	7.5	7.6	511	524	1.3	50
08-AUG-83	7.0	7.7		500	518	2.5	70
15-AUG-83	10.1	7.7	7.1	513	554	3.5	60
12-SEP-83	9.5	7.9		537	440	1.8	50
03-OCT-83	8.9	7.8	7.8	607	453	2.1	50
16-OCT-83	9.8	7.8	8.3	606	441	2.5	50
12-DEC-83							

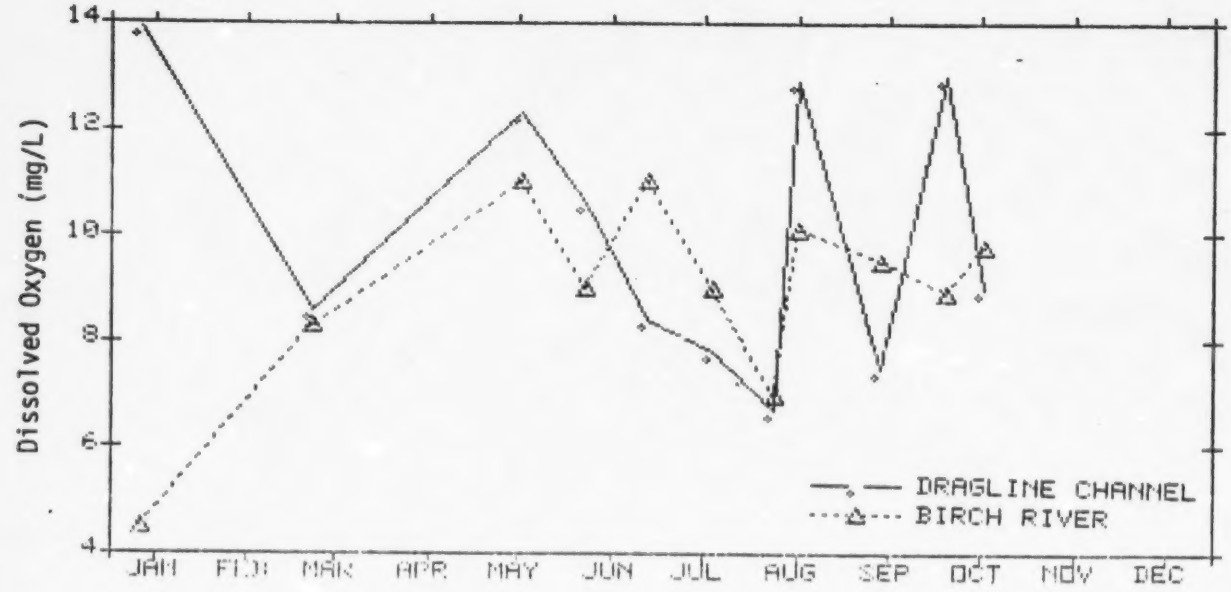
Date	Temp Lab	Temp Field	T.D.S. Calc	N.F.R. 105 C.	P Total	N Total	N Diss
10-JAN-83	12.5	1.0	331	3	0.076	0.88	0.78
07-MAR-83	19.1	0.5	361	20	0.280	1.40	1.10
16-MAY-83	23.2	4.0	464	11	0.096		
06-JUN-83	22.2	15.0	431	2	0.120		
27-JUN-83	20.1	19.0	380	1	0.040	0.79	0.76
18-JUL-83	16.6	19.0	264	3	0.043	0.82	0.78
08-AUG-83	25.9	23.0	258	3	0.043	1.00	0.89
15-AUG-83	20.9	15.0	277	5	0.070	1.00	0.87
12-SEP-83	21.7	18.5	277	2	0.046	1.10	1.00
03-OCT-83	16.9	8.0	322	2	0.040	1.20	1.10
16-OCT-83	15.8	5.5	325	2	0.033	1.30	1.10
12-DEC-83							

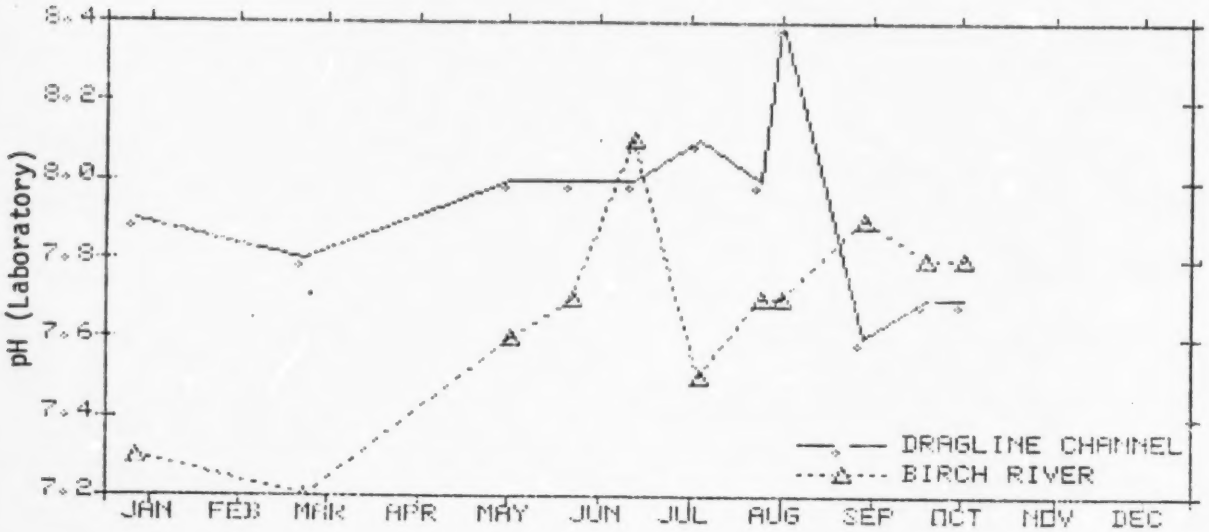
Date	N Part	N NO23	N NH3	C DissOrg	C PartOrg	Chlor a	Phenol ug/l
10-JAN-83	0.10	0.020	0.30	12	0.62	0.004	0.004
07-MAR-83	0.30	0.005	0.70	19	1.90	0.003	0.005
16-MAY-83			0.05			0.030	0.009
06-JUN-83			0.05			0.004	0.008
27-JUN-83	0.03	0.010	0.05	16	0.24	0.002	0.009
18-JUL-83	0.04	0.010	0.05	16	0.30	0.001	0.009
08-AUG-83	0.11	0.005	0.05	18	0.67	0.008	
15-AUG-83	0.15	0.010	0.05	21	0.97	0.004	0.009
12-SEP-83	0.13	0.020	0.10	19	0.94	0.010	0.005
03-OCT-83	0.13	0.050	0.40	20	0.79	0.002	0.005
16-OCT-83	0.17	0.070	0.30	18	1.00	0.001	0.006
12-DEC-83							

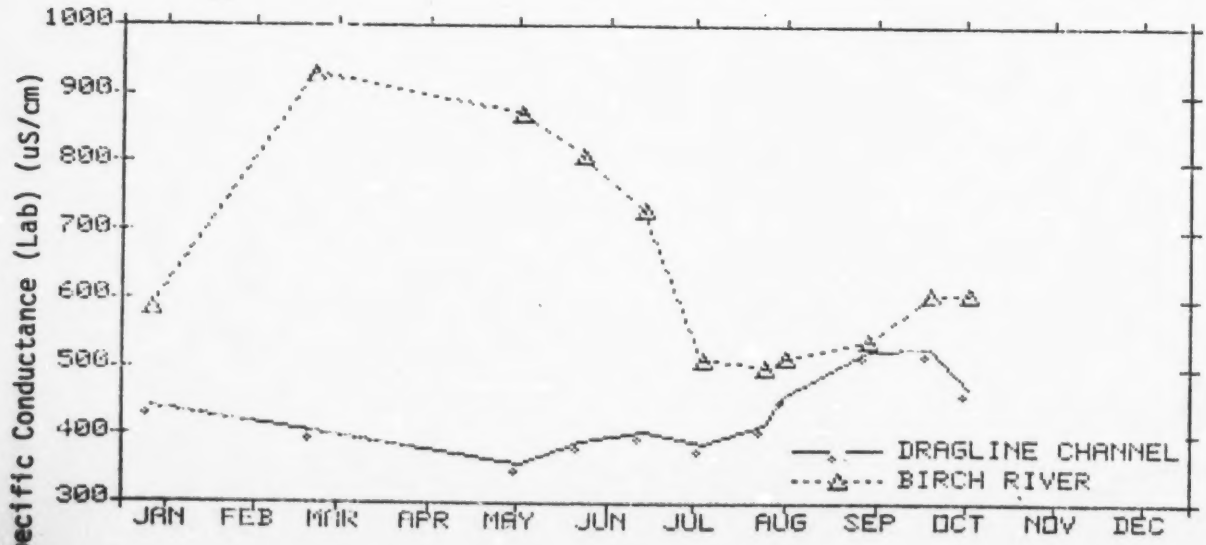
Date	Coli-T	Coli-F	Alk-T	Alk-P	Ca	Mg	T-Hard Calc
10-JAN-03	1	1	200	0	52.2	22.7	224
07-MAR-03	12	6	330	0	84.5	37.5	365
16-MAY-03	1	1	305	0	76.6	31.0	319
06-JUN-03	1	1	280	0	71.7	29.0	299
27-JUN-03	1	1	250	0	62.8	25.5	262
18-JUL-03			145	0	36.3	18.5	167
08-AUG-03			135	0	31.3	18.8	156
15-AUG-03			140	0	32.2	19.7	162
12-SEP-03			150	0	34.9	19.5	167
03-OCT-03	300	56	180	0	41.3	21.8	193
16-OCT-03			190	0	43.1	22.4	200
12-DEC-03							

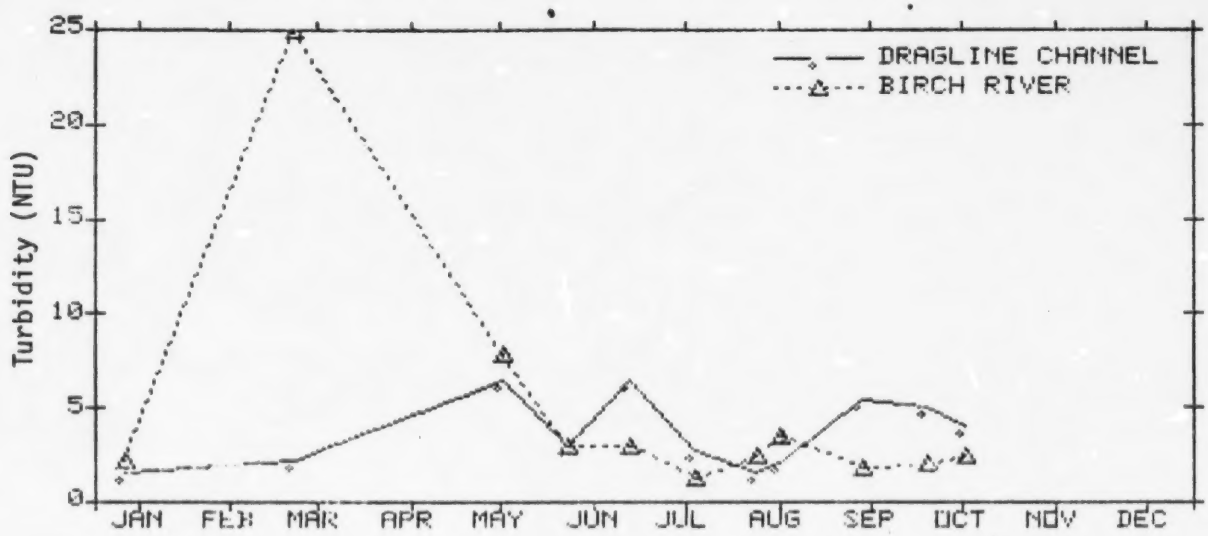
Date	Bicarb Calc	SO4	Cl	SiO2	F	Na	K	Arsenic Diss
10-JAN-03	244	26.0	62	2.9	0.15	40	5.3	0.00025
07-MAR-03	402	24.0		9.2			8.0	0.00210
16-MAY-03	372	9.2	90	12.0	0.13	55	7.2	0.00025
06-JUN-03	341	11.0	84	10.0	0.19	50	6.9	0.00025
27-JUN-03	305	5.6	76	6.2	0.13	47	6.2	0.00060
18-JUL-03	177	5.2	68	4.4	0.11	40	4.0	0.00050
08-AUG-03	165	4.8	67	8.7	0.13	42	3.9	0.00070
15-AUG-03	171	6.0	75	11.0	0.13	45	4.2	
12-SEP-03	183		75	8.2	0.11	44	4.9	0.00190
03-OCT-03	219	9.0	80	8.8	0.10	47	5.3	0.00210
16-OCT-03	219	9.4	84	8.9	0.12	44	4.8	0.00230
12-DEC-03								

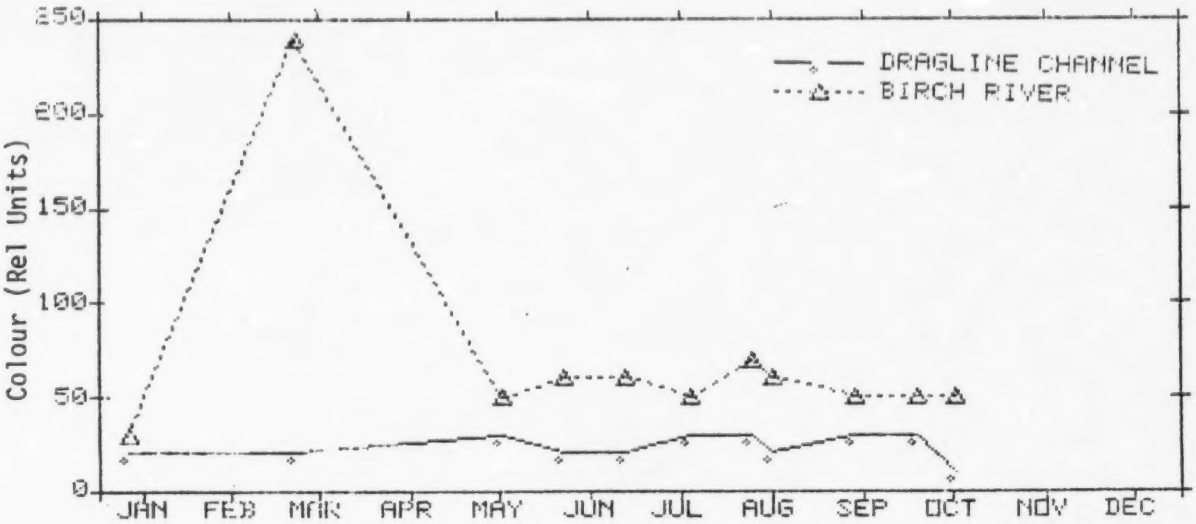
Date	Iron Ext	Mn Ext	Copper Total	Lead Total
10-JAN-03	0.34	0.31	0.0005	0.002
07-MAR-03	6.90	0.96	0.0005	0.002
16-MAY-03	2.00	0.10	0.0005	0.002
06-JUN-03	0.26	0.21	0.0005	0.002
27-JUN-03	0.58	0.21	0.0005	0.002
18-JUL-03	0.48	0.07	0.0010	0.002
08-AUG-03	0.75	0.13	0.0005	0.002
15-AUG-03				
12-SEP-03			0.0005	0.002
03-OCT-03	0.33	0.14	0.0010	0.002
16-OCT-03	0.32	0.11	0.0020	0.003
12-DEC-03				

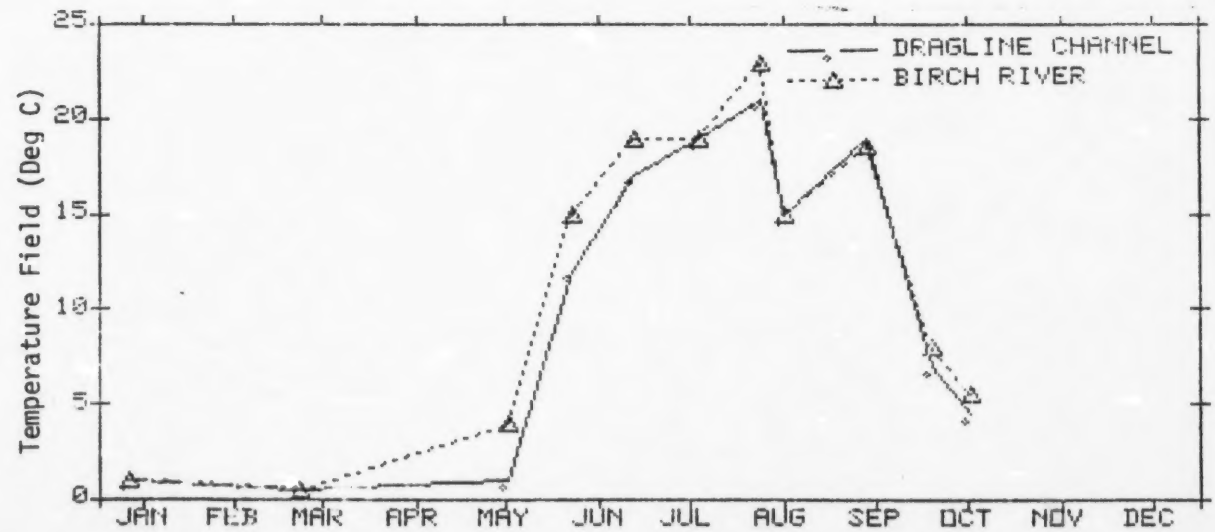

Dissolved Oxygen (mg/L)
14
12
10
8
6
4
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
DRAGLINE CHANNEL
BIRCH RIVER


pH (Laboratory)
8.4
8.2
8.0
7.8
7.6
7.4
7.2
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
DRAGLINE CHANNEL
BIRCH RIVER

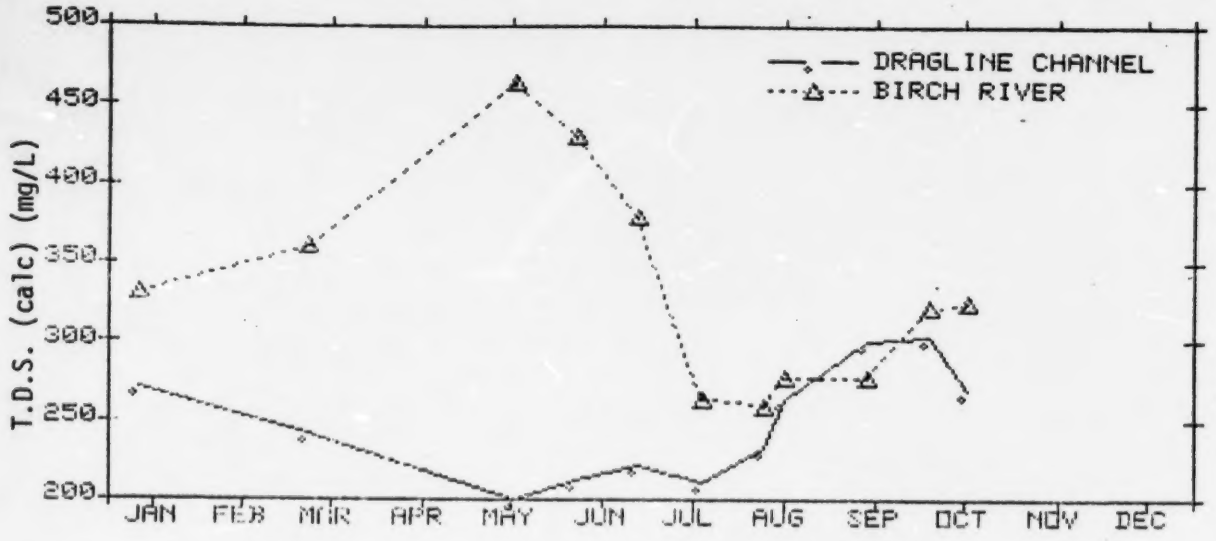

Specific Conductance (Lab) (uS/cm)
1000
900
800
700
600
500
400
300
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
DRAGLINE CHANNEL
BIRCH RIVER

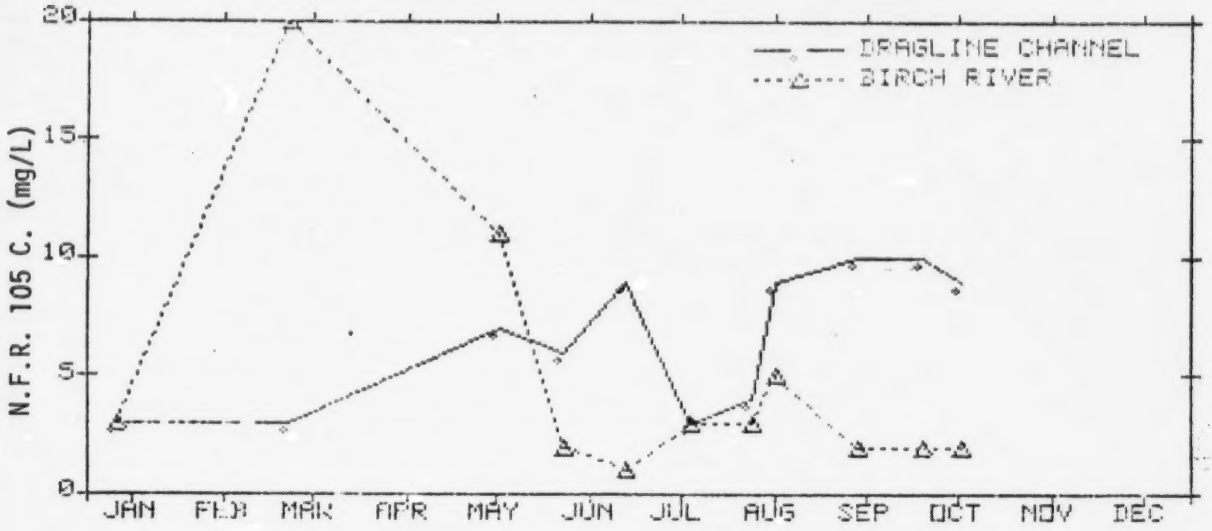

DRAGLINE CHANNEL
BIRCH RIVER
Turbidity (NTU)
25
20
15
10
5
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

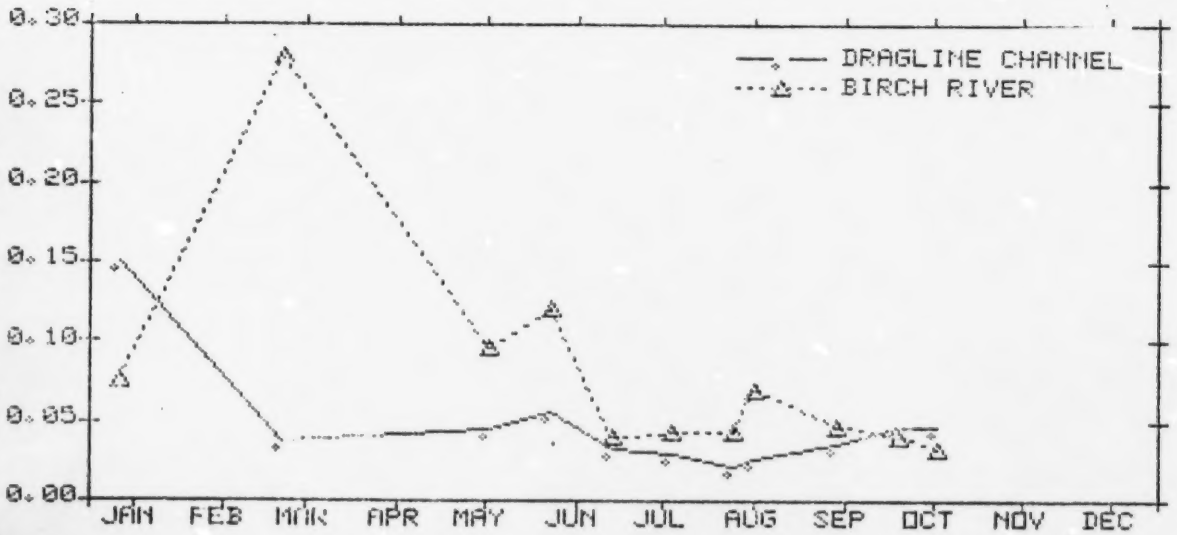

DRAGLINE CHANNEL
BIRCH RIVER
Colour (Rel Units)
250
200
150
100
50
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


DRAGLINE CHANNEL
BIRCH RIVER
Temperature Field (Deg C)
25
20
15
10
5
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

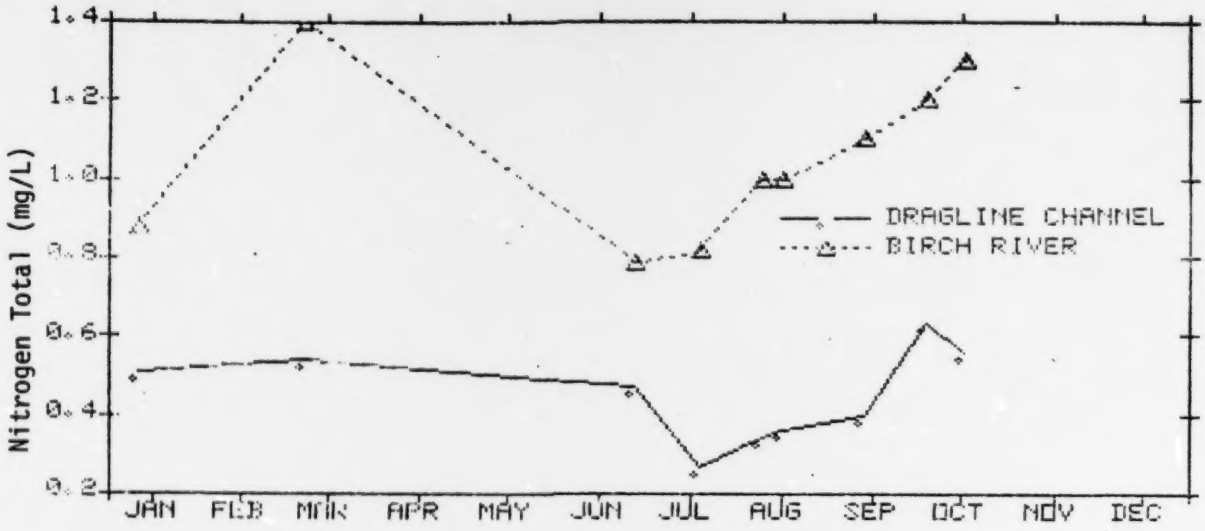
1983

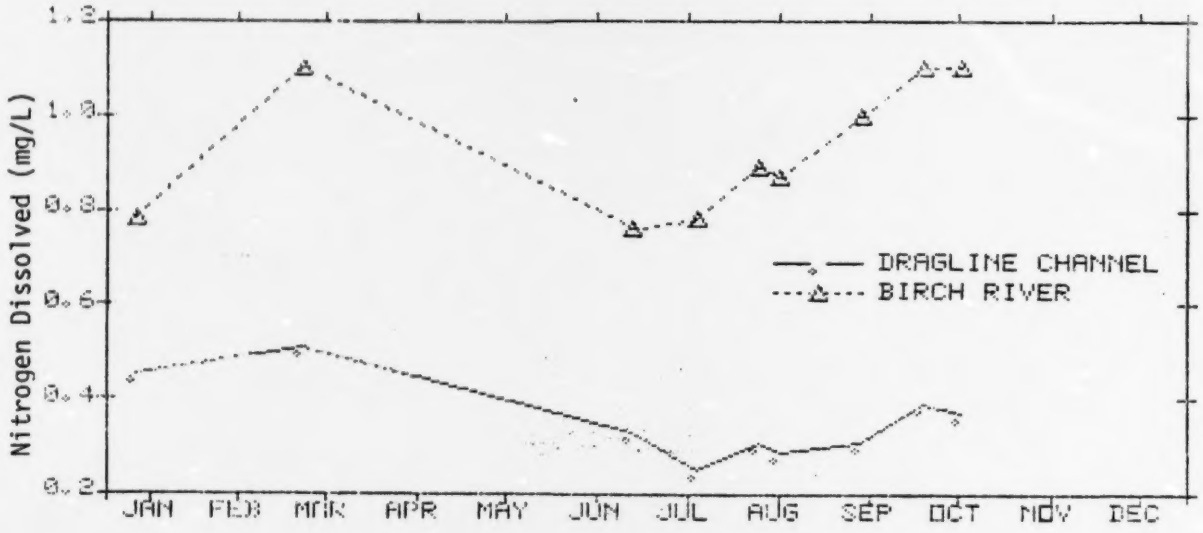

DRAGLINE CHANNEL
BIRCH RIVER
T.D.S. (calc) (mg/L)
500
450
400
350
300
250
200
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

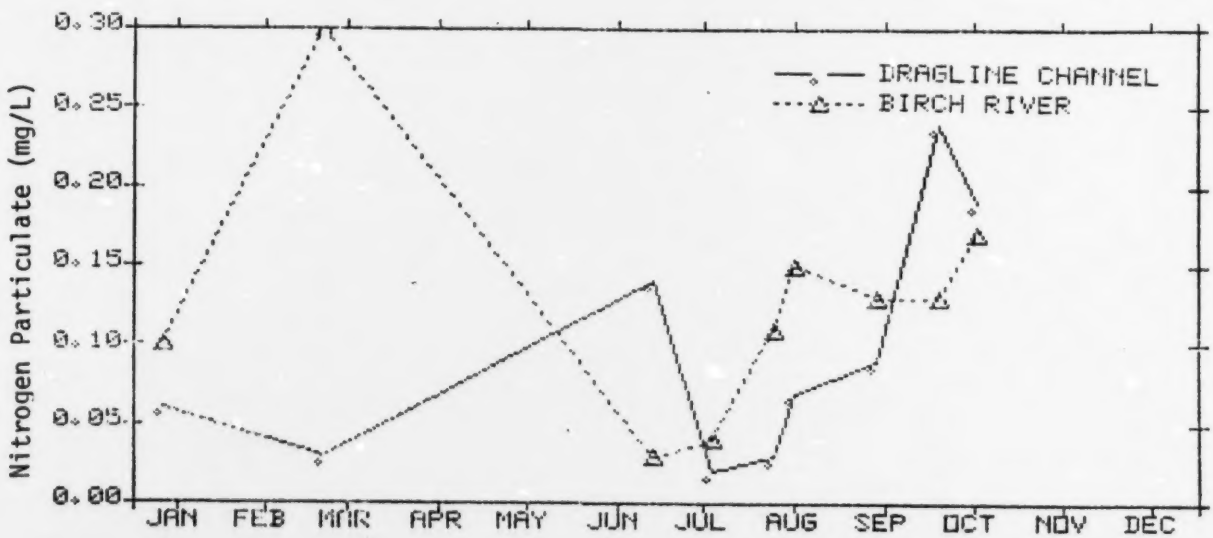

DRAGLINE CHANNEL
BIRCH RIVER
N.F.R. 105 C. (mg/L)
20
15
10
5
0
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC


DRAGLINE CHANNEL
BIRCH RIVER
Phosphorus Total (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

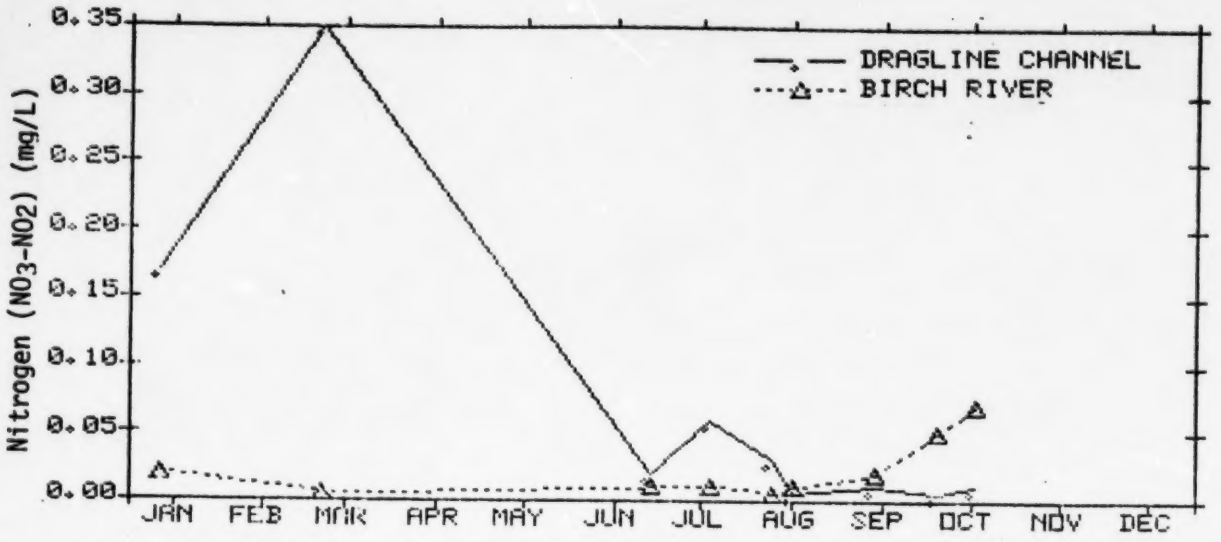
1983

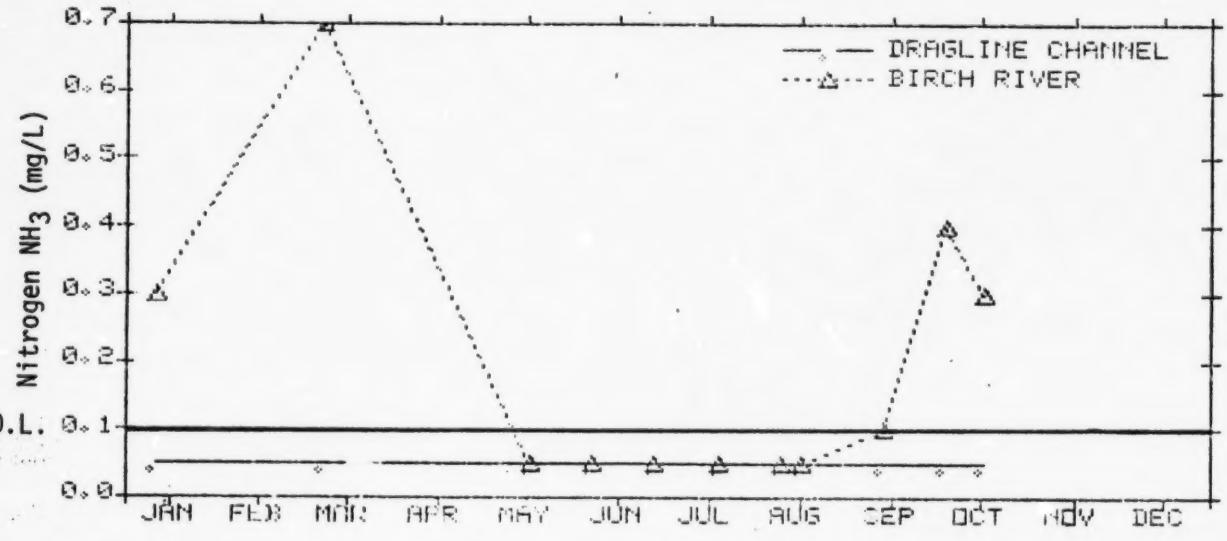

Nitrogen Total (mg/L)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
DRAGLINE CHANNEL
BIRCH RIVER
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

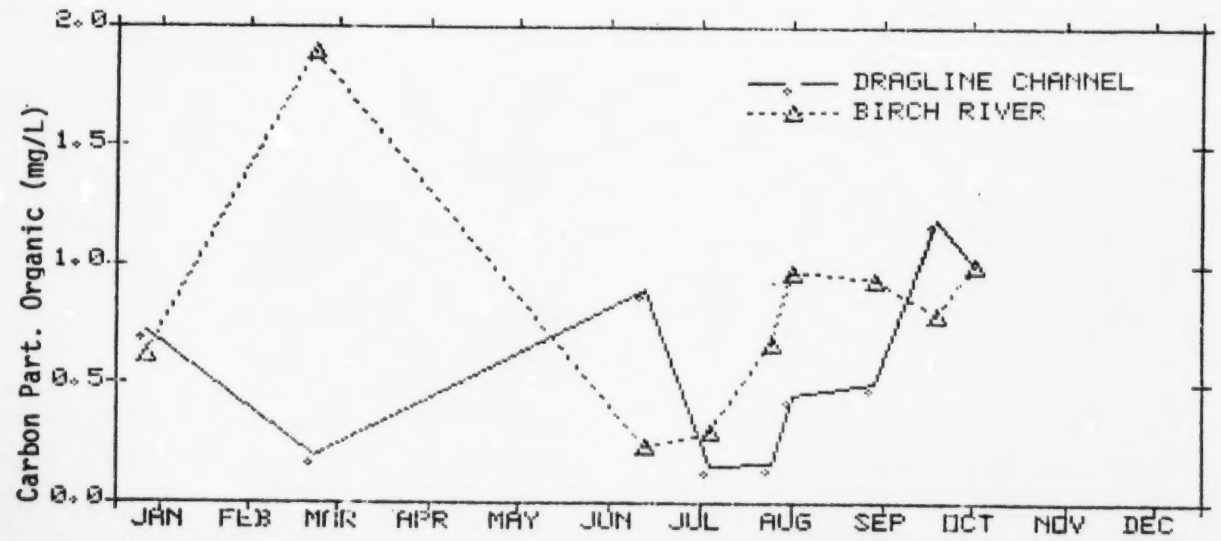

Nitrogen Dissolved (mg/L)
1.2
1.0
0.8
0.6
0.4
0.2
DRAGLINE CHANNEL
BIRCH RIVER
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC


Nitrogen Particulate (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
DRAGLINE CHANNEL
BIRCH RIVER
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

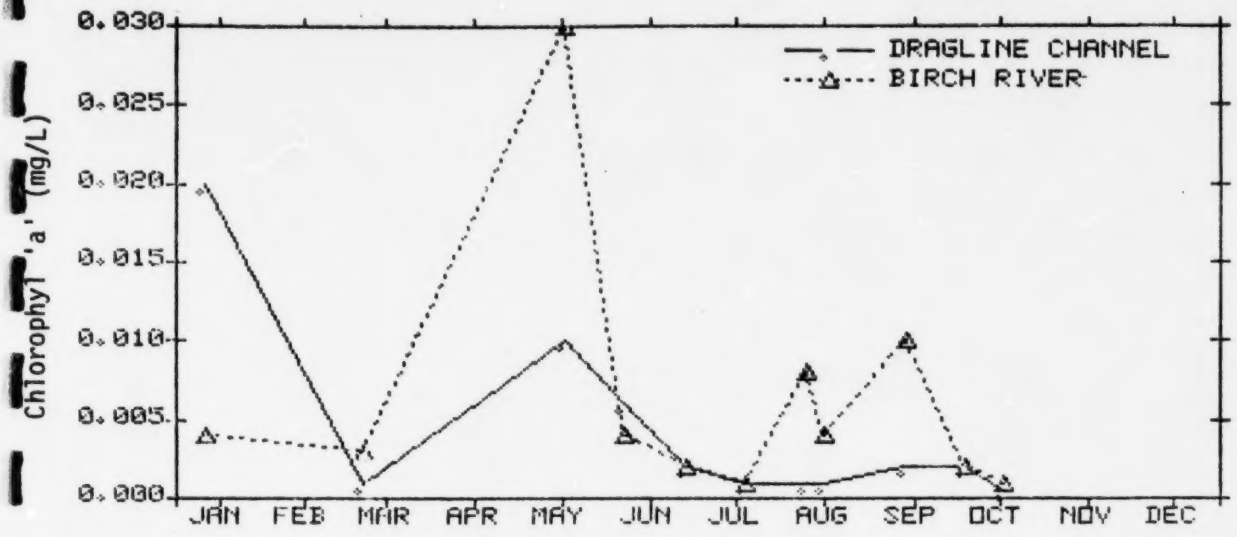
1983

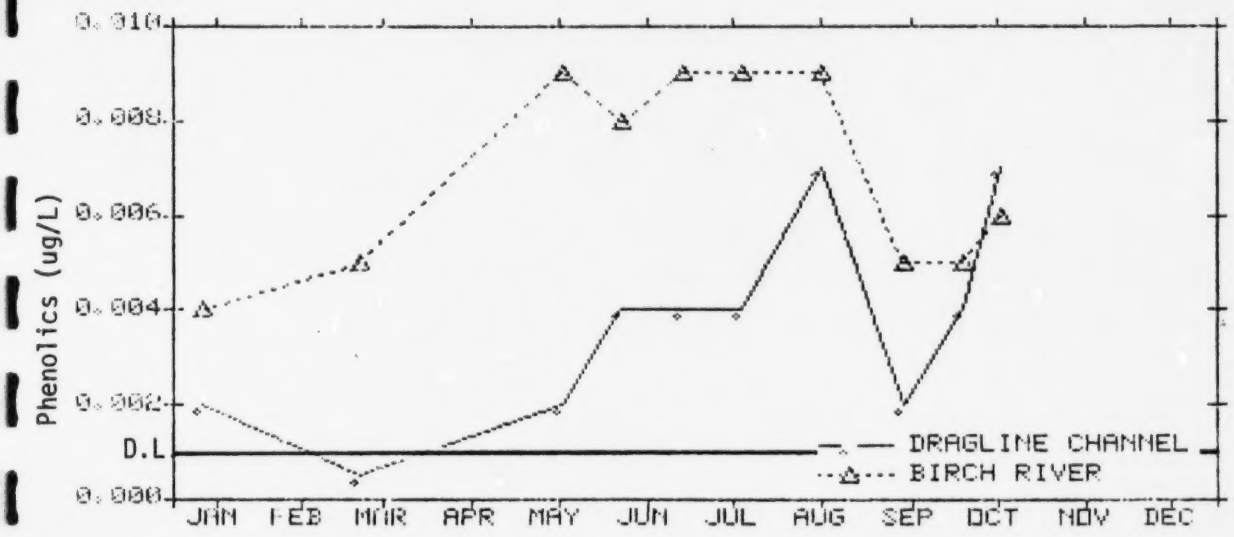

Nitrogen (NO_3-NO_2) (mg/L)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
DRAGLINE CHANNEL
BIRCH RIVER
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

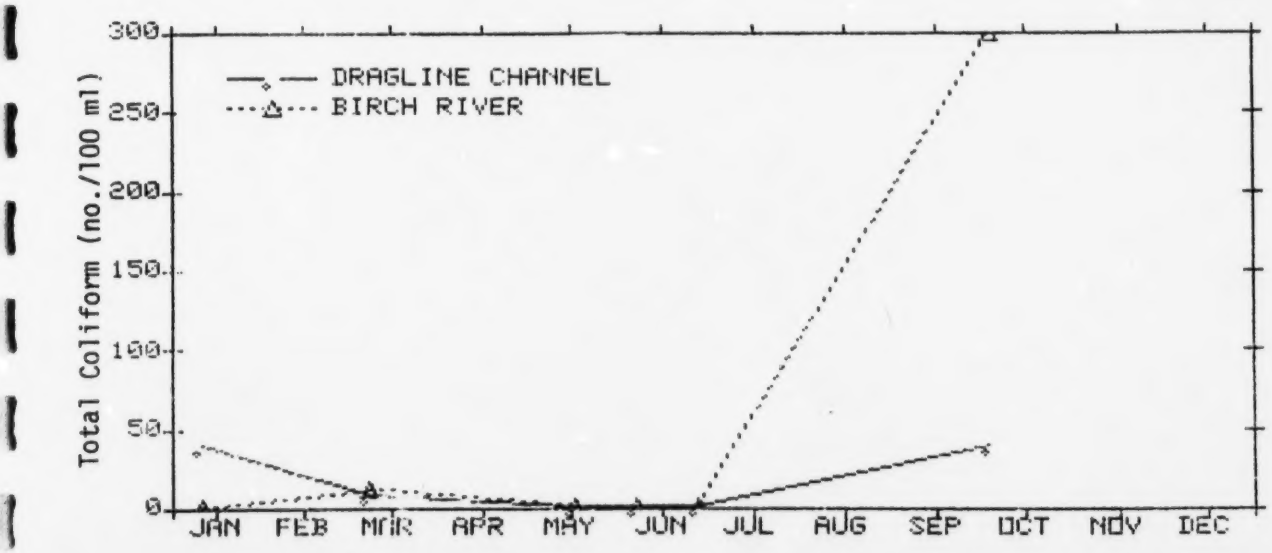

Nitrogen NH_3 (mg/L)
D.L.
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
DRAGLINE CHANNEL
BIRCH RIVER
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC


Carbon Part. Organic (mg/L)
2.0
1.5
1.0
0.5
0.0
DRAGLINE CHANNEL
BIRCH RIVER
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

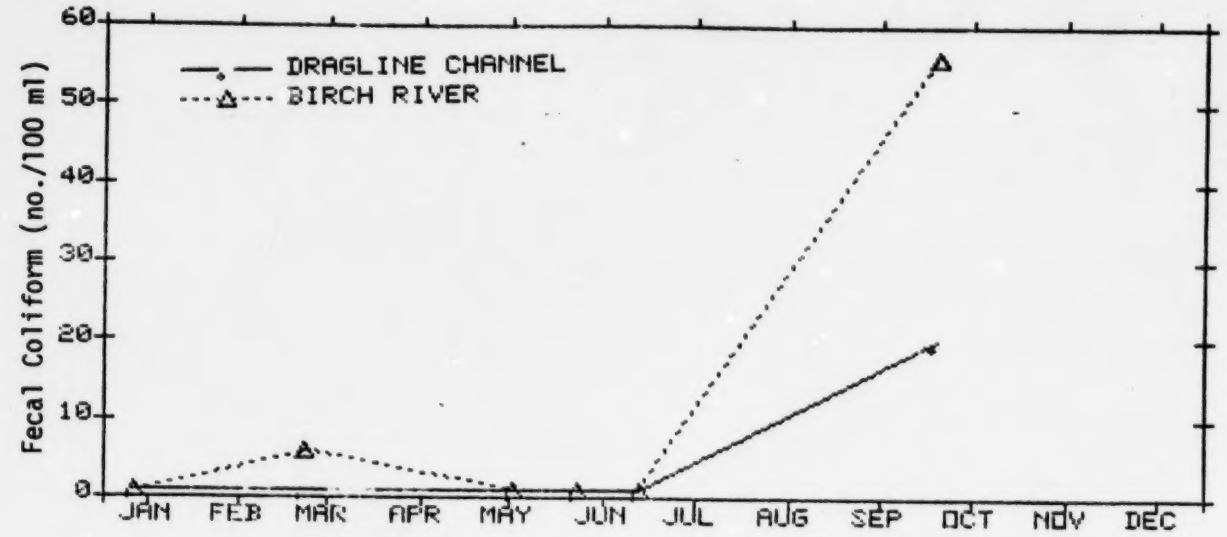
1983

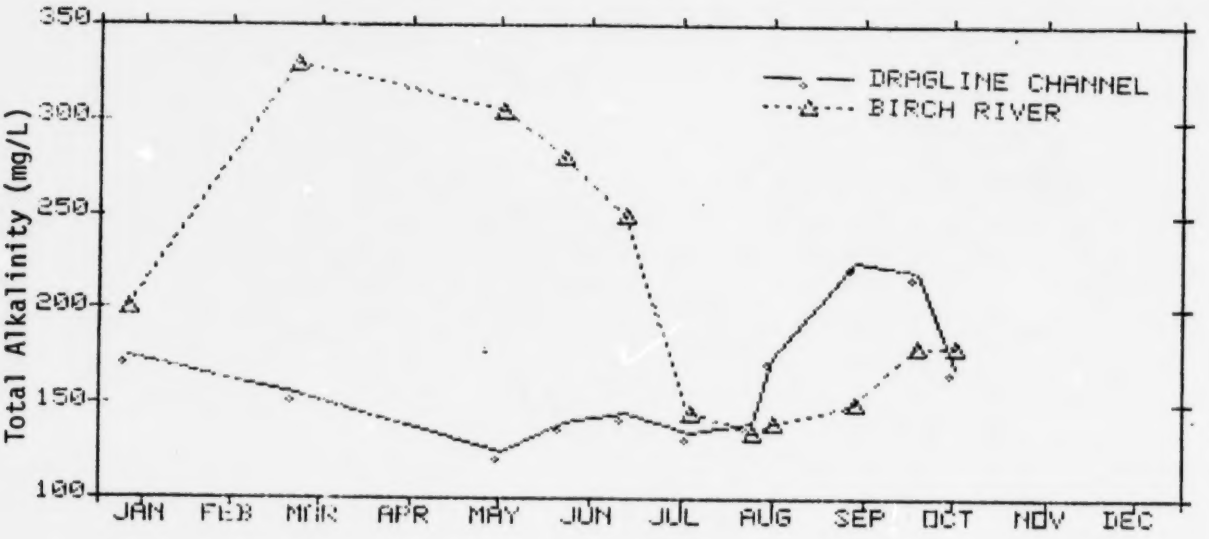

Chlorophyl 'a' (mg/L)
0.030
0.025
0.020
0.015
0.010
0.005
0.000
DRAGLINE CHANNEL
BIRCH RIVER
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC


Phenolics (ug/L)
0.010
0.008
0.006
0.004
0.002
D.L
0.000
DRAGLINE CHANNEL
BIRCH RIVER
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC


Total Coliform (no./100 ml)
300
250
200
150
100
50
0
DRAGLINE CHANNEL
BIRCH RIVER
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

1983


DRAGLINE CHANNEL
BIRCH RIVER
Fecal Coliform (no./100 ml)
60
50
40
30
20
10
0
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC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BIRCH RIVER
Total Alkalinity (mg/L)
350
300
250
200
150
100
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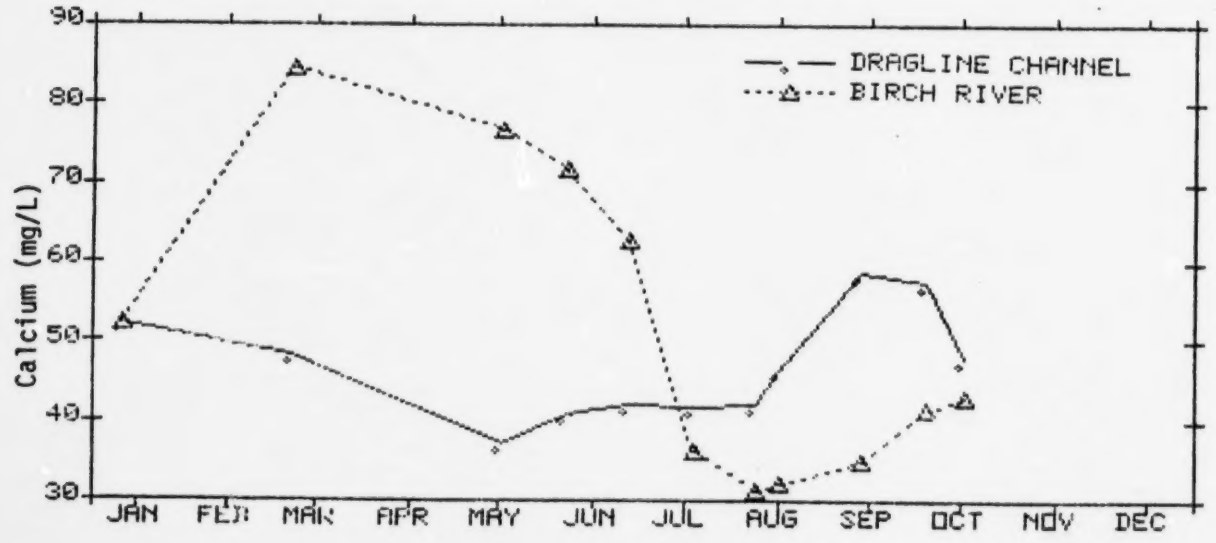
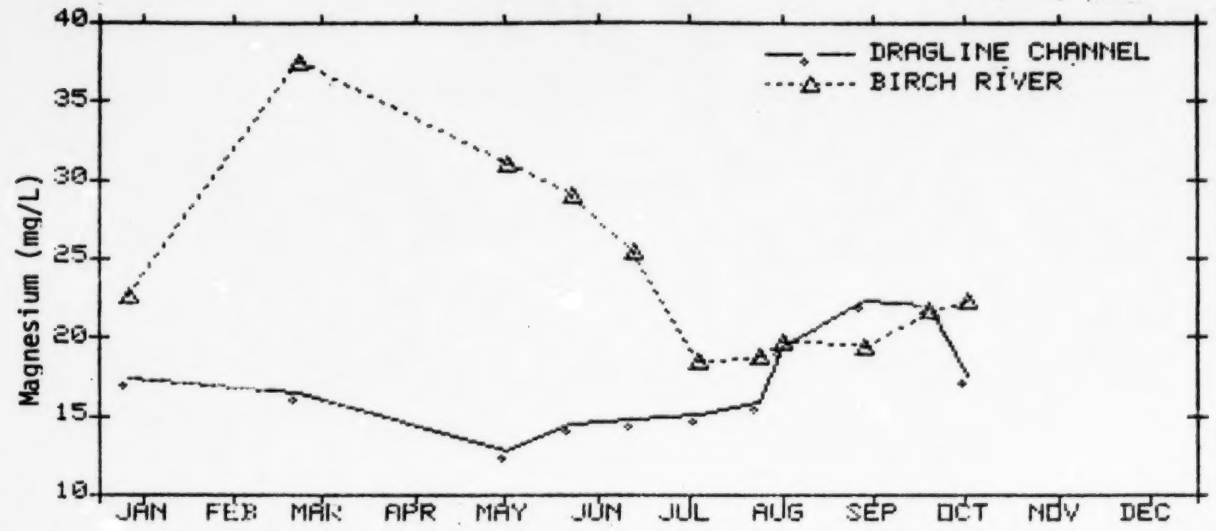
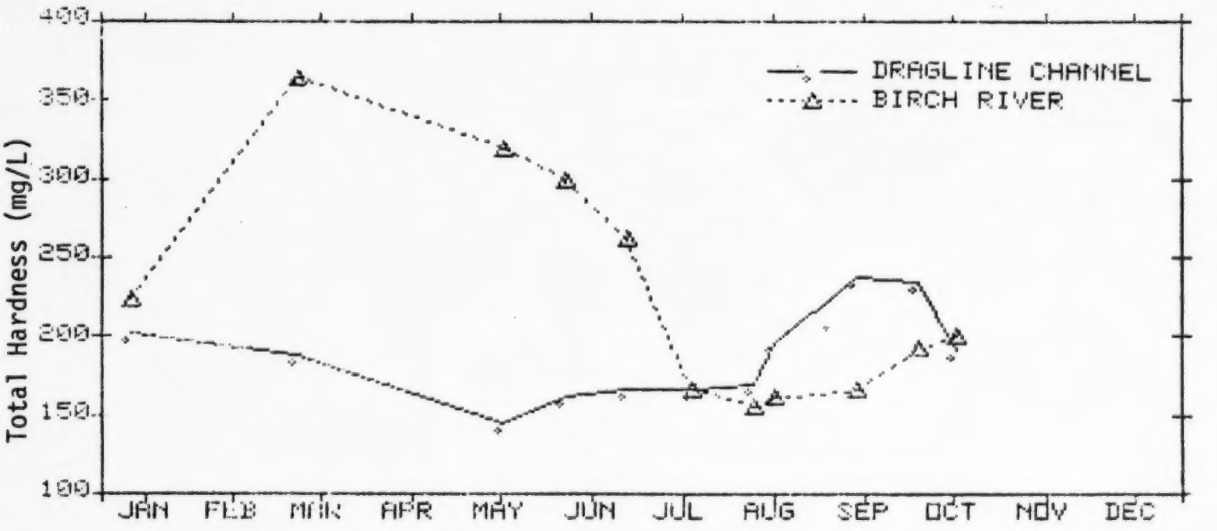
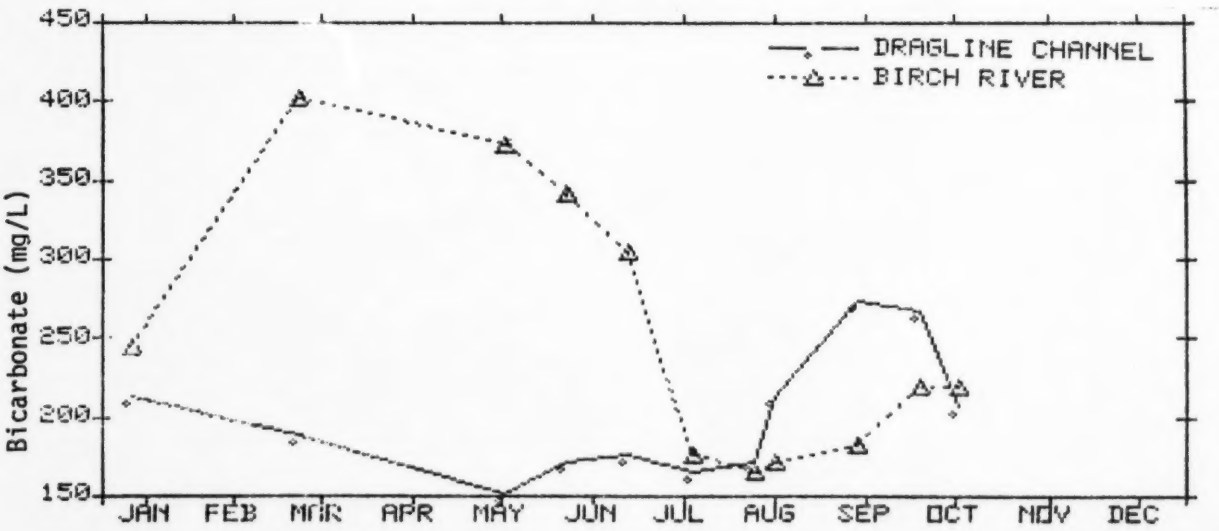

DRAGLINE CHANNEL
BIRCH RIVER
Calcium (mg/L)
90
80
70
60
50
40
30
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

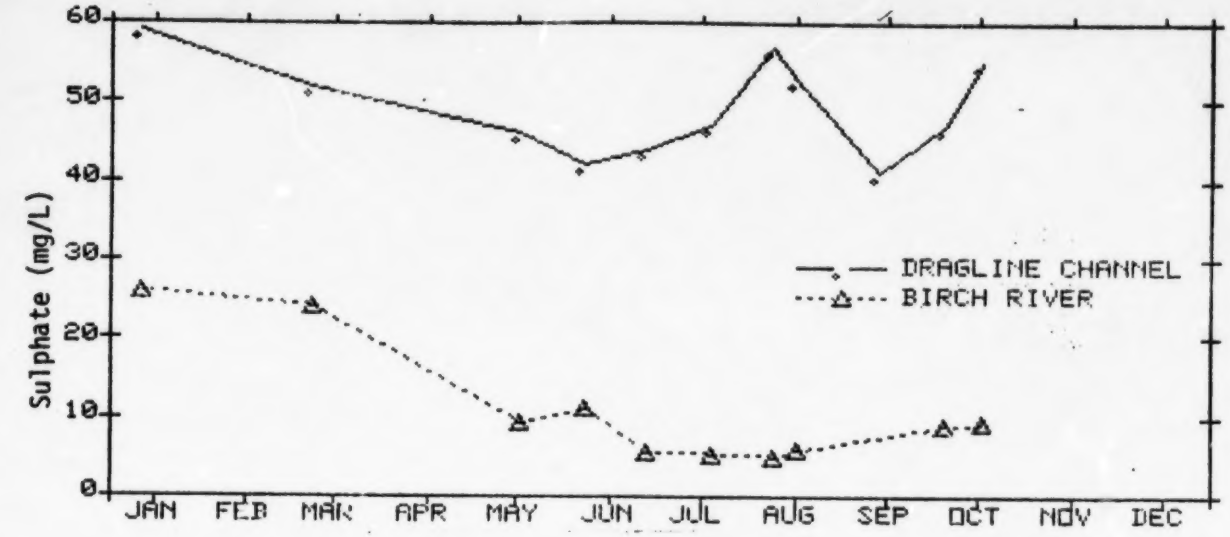
1983

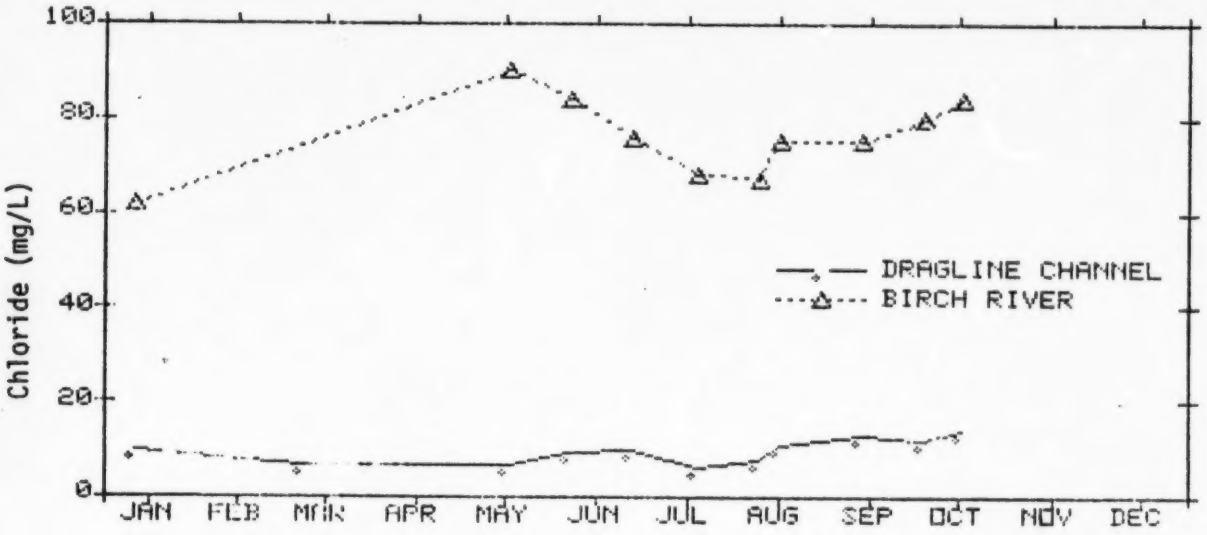

DRAGLINE CHANNEL
BIRCH RIVER
Magnesium (mg/L)
40
35
30
25
20
15
10
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

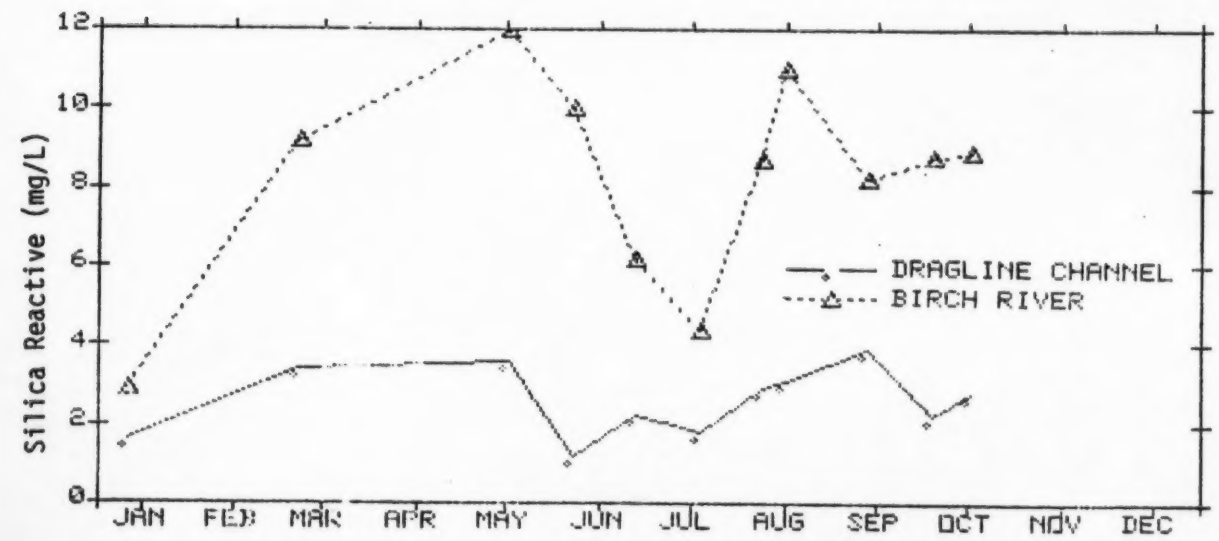

DRAGLINE CHANNEL
BIRCH RIVER
Total Hardness (mg/L)
400
350
300
250
200
150
100
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC


DRAGLINE CHANNEL
BIRCH RIVER
Bicarbonate (mg/L)
450
400
350
300
250
200
150
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

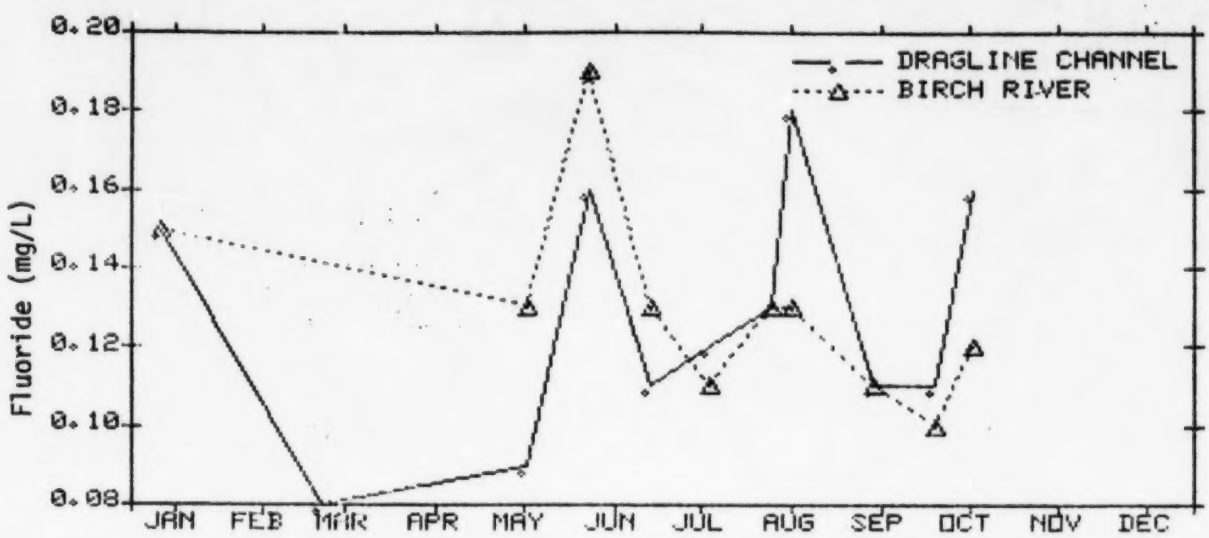
1983

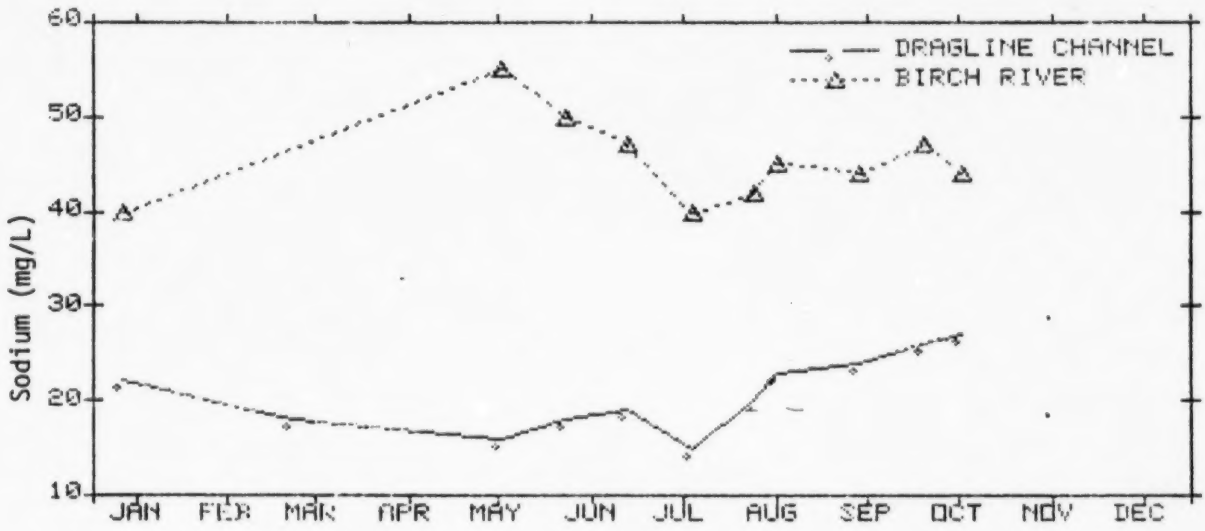

Sulphate (mg/L)
60
50
40
30
20
10
0
DRAGLINE CHANNEL
BIRCH RIVER
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

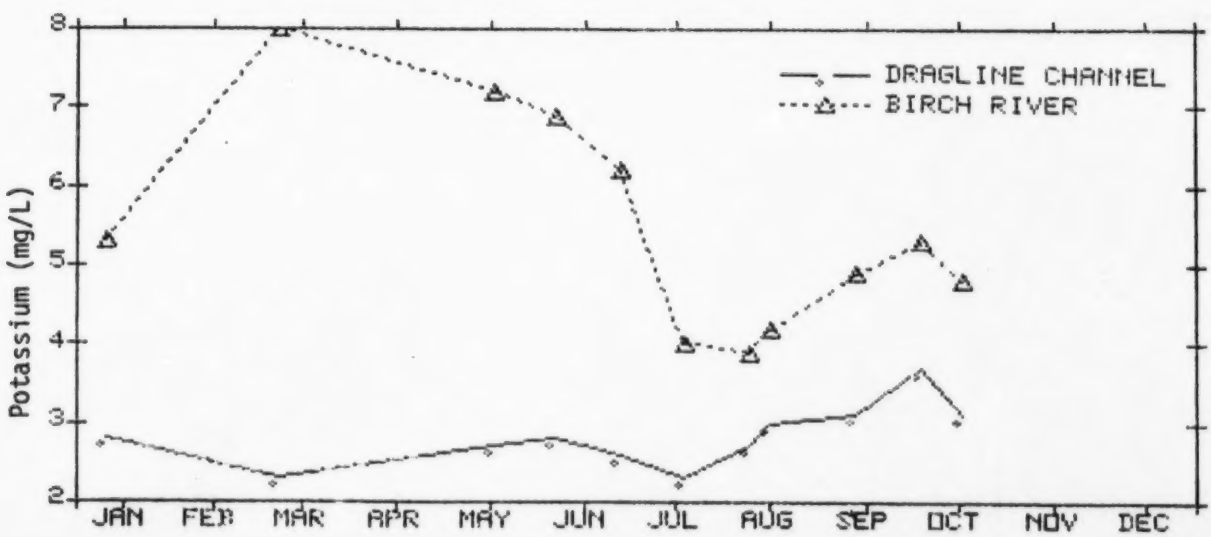

Chloride (mg/L)
100
80
60
40
20
0
DRAGLINE CHANNEL
BIRCH RIVER
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC


Silica Reactive (mg/L)
12
10
8
6
4
2
0
DRAGLINE CHANNEL
BIRCH RIVER
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

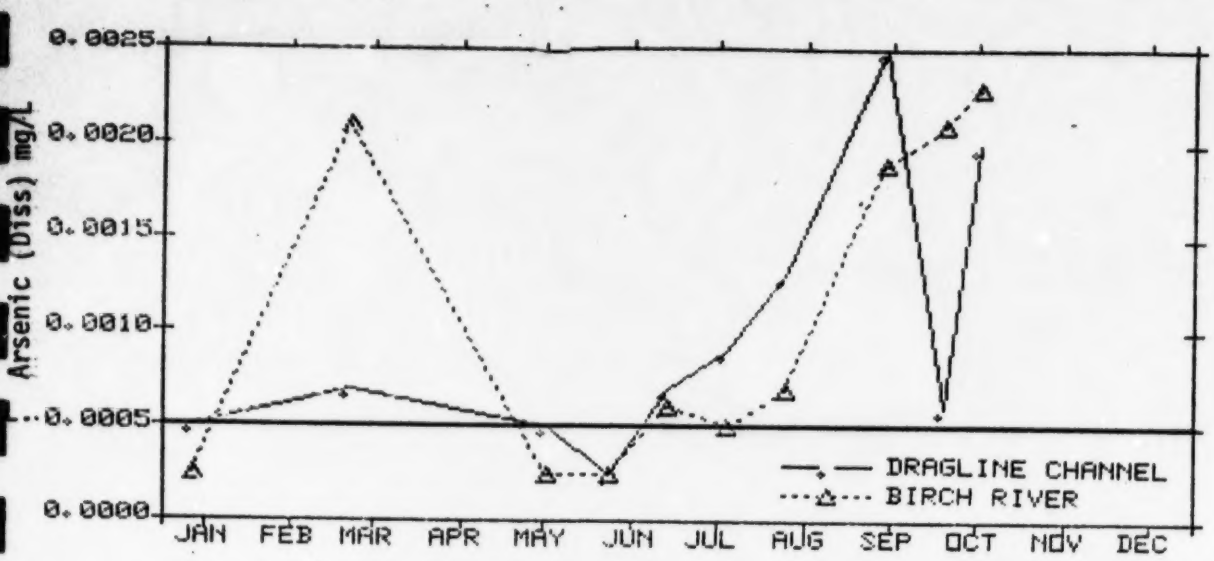
1983

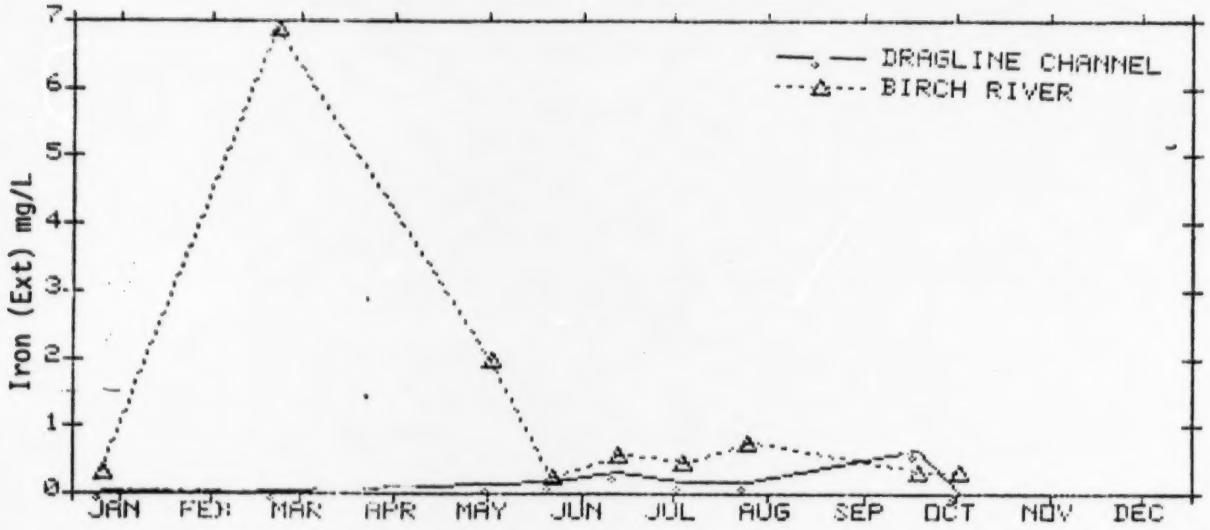

0.20
0.18
0.16
0.14
0.12
0.10
0.08
Fluoride (mg/L)
DRAGLINE CHANNEL
BIRCH RIVER
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

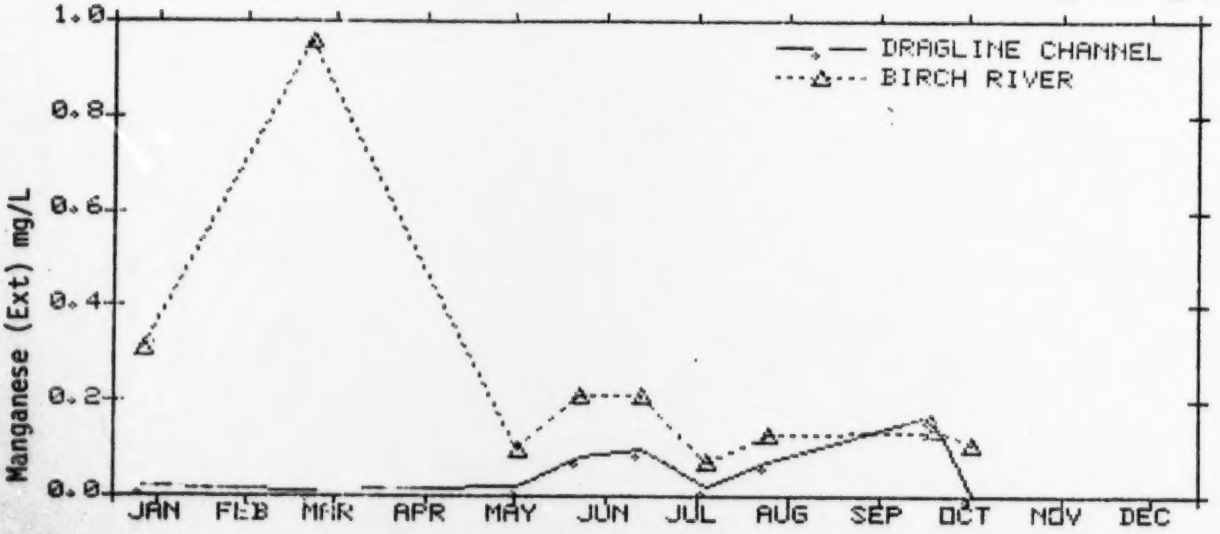

60
50
40
30
20
10
Sodium (mg/L)
DRAGLINE CHANNEL
BIRCH RIVER
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC


8
7
6
5
4
3
2
Potassium (mg/L)
DRAGLINE CHANNEL
BIRCH RIVER
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

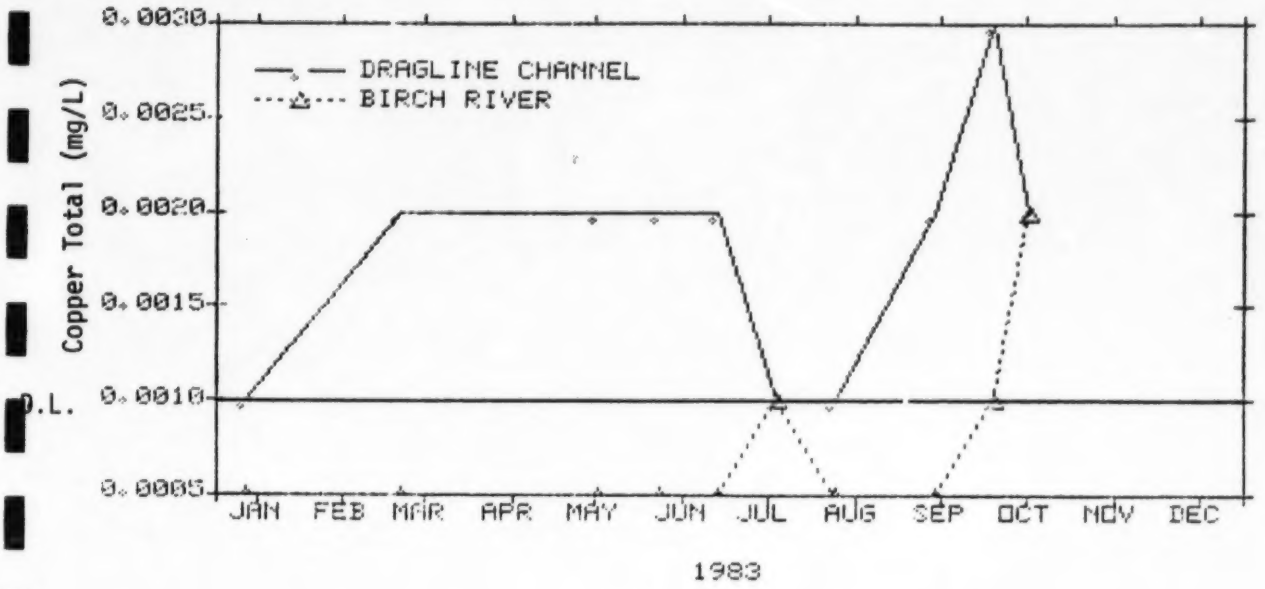
1983


Arsenic (Diss) mg/L
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
DRAGLINE CHANNEL
BIRCH RIVER


Iron (Ext) mg/L
7
6
5
4
3
2
1
0
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
DRAGLINE CHANNEL
BIRCH RIVER


Manganese (Ext) mg/L
1.0
0.8
0.6
0.4
0.2
0.0
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
DRAGLINE CHANNEL
BIRCH RIVER

1983


0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
D.L.
Copper Total (mg/L)
DRAGLINE CHANNEL
BIRCH RIVER
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1983

APPENDIX C

Ducks Unlimited Canada
1606 - 4th Avenue, Box 4465 Regina, Saskatchewan S4P 3W7 (306) 569-0424

May 24, 1984

Alex Banga
Hydrology Branch
Department of the Environment
1855 Victoria Avenue
Regina, Saskatchewan
S4P 3V5

Dear Sir:

RE: Cumberland Operations for 1983 (our file C-5)
and Hydrometric Status 05KH014

Attached is our 1983 Operations Report. I apologize for the delay in submission of this years report.

If you require further information please advise.

Sincerely,

Lois E Lee

for A.R. Iverson
Provincial Engineer

ARI/ll

xc. R.A. Halliday
Water Survey of Canada

1983 Cumberland Marshes Operations Report

Dave Phillips
Area Biologist
Ducks Unlimited Canada
Cumberland House, Sask.
November 3, 1983

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3.0 Flow sources on water qaulity sampling dates ..... page 7.
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1.0 Introduction

Since 1978, Ducks Unlimited Canada has conducted a water quantity/quality monitoring program at the Cumberland Marshes project in co-operation with the Water Survey of Canada and Water Quality Branch of Environment Canada. The program seeks to compile annual surface water data to document flows entering and leaving the project as well as water quality trends attributable to project operations.

The present report has been prepared to summarize 1983 operations at the project for both agencies. This combined approach began during 1982 to simplify annual reporting procedures. It is hoped that this format continues to provide adequate documentation for interpretations of both flows and water quality results.

As in past years, Hydrometric Station #05KH014 was used to determine discharges from the Cumberland project to Manitoba via the Cumberland Marshes Dam on the Birch River. Wier formula estimates of mean daily flows at the structure have again been calculated from water level records at the station and appear in this report. Personel from the Water Survey of Canada metered flows below the Cumberland dam on two occasions during the 1983 operating season to verify the accuracy of these wier formula estimates. In previous years we had used a weir width of 10 feet in our calculations inspite of the fact that the actual length is 11 feet. It was felt that using a 10 foot width would compensate for entrance loses due to floating debris, etc. The results of the sample metering would indicate that a much closer correlation would result if the actual width of 11 feet was used. The calculations for 1983 (Table 1) used the increased weir length as will future calculations.

Inflow diverted from the Old Channel of the Saskatchewan River was recorded by Hydrometric Station #05KH011 at the Dragline Channel with bi-monthly gauging of the station carried out by Ducks Unlimited staff. The theoretical water balance calculated in this report indicates a total diversion of approximately 18,000 acre feet; verification of this estimate will be provided by publication of flows at the station by Water Survey Canada.

Simultaneous water quality samples have been collected on 11 occassions during the year at the Birch River and Dragline Channel collection sites; three (3) outstanding samples scheduled under the terms of the 1983/84 contract with Environment Canada will be collected before April, 1984.

2.0 General Operations

During the winter of 1982/83, over-winter fish survival in Cut Beaver storage reservoir was protected by providing continuous inflow from the Old Channel via the Dragline Channel. Although adequate levels of dissolved oxygen were maintained with this procedure, attempts to hold inflow rates at the 30 cfs specified by the Provincial Fisheries Branch failed when one bay of the inlet control froze open. When discharges in the Old Channel fell sharply during late November, efforts to maintain

inflow by lifting this gate caused it to break free from its control rod. This broken bay remained frozen open until early February when the control was steamed open, repaired and reset to its proper setting. Over this period inflow was unregulated and varied between 80 and 130 cfs in response to discharge rates from the Squaw Rapids hydroelectric facility upstream.

These heavy flows over the winter combined with average local run-off resulted in a complete refill of the storage reservoir by spring break-up. Although the Dragline Channel inlet control continued to flow at the 30 cfs winter rate until June 10 when beavers completely sealed the upstream side of the structure, the traditional refill operation which usually is completed during spring and summer was not required during 1983. The inlet control presently remains closed and will be re-opened to establish winter flows during November. On the basis of bi-monthly flow metering at the Dragline Channel, the total diversion from the Old Channel to Cut Beaver Lake is estimated to have been 17,600 acre feet between November 1, 1982 and June 10, 1983.

Spring break-up was unusually late in the Cumberland area with prolonged cool temperatures and overcast conditions maintaining persistent ice cover until May 18. Initial plans to begin in McGregor Lake drawdown in early May were revised to accomodate downstream operations in the Carrot River Triangle area. Manitoba Fisheries personel involved with fish monitoring studies at the Bracken Dam requested a delay in the initiation date for this drawdown via the Inter-Provincial Water Management Meeting in early April. To meet this request, discharges from the project were delayed until June 28 when the Cumberland Marshes Dam was opened.

The McGregor Lake drawdown was completed by August 31 with Birch River Marsh Centre also lowered to accept discharge during this period. Extensive settlement along sections of the Birch River Marsh South dyke required that this unit adjacent to the Centre cell also be lowered to prevent further erosion as water levels fell in the Birch River. Estimated mean daily flows over the Cumberland Marshes dam during the drawdown are presented in Table 1 and stop log settings on the structure appear in Table 2. The total estimated discharge over the period estimated to have been 20,058 feet which compares favorably with the estimated volume reductions on Birch River Marsh Centre, Birch River Marsh South and McGregor Lake (19,572 acre feet; Table 3). Run-off into McGregor Lake will be drained via the Cumberland Marshes Dam during May, 1984 with complete refill of this unit scheduled for 1985.

Retopping operations began on June 29 when the West Channel control structure was opened after fish screening nets were installed on the outlets of Cut Beaver Lake. Units retopped included Deep Lake, Bloodsucker Lake, Highbank Lake, Waterhen Lake, Egg Lake and West Wapisew Lake for a total volume demand of 5,291 acre feet (Table 3) from Cut Beaver Lake. Although evaporative water loss within the project was low during June and July due to significant precipitation contribution, extremely hot and dry conditions during August and early September caused lake levels to fall by approximately 0.3 feet. Replacement of this evapo-transpirative loss required an estimated 10,819 acre feet from Cut Beaver Lake (Table 3).

Table 1. Estimated mean daily discharges from the Cumberland Marshes Project into the Birch River via the Cumberland Marshes Dam during 1983.

Date	Flow (c.f.s.)	Volume (ac.ft.)	Operations contributing to flow
June 28 *	293.7	587.4	- Opened Cumberland Dam & McGregor Lake outlet control
29	242.3	484.7	
30	259.6	519.2	
		1,501.3	
July 1	256.1	512.2	
2	259.6	519.2	
3	272.8	545.6	
4	270.2	540.3	
5	263.1	526.2	
6	250.8	501.6	- Cleared floating debris above dam
7	231.9	463.8	
8	226.8	453.6	- Inspected dam
9	216.9	433.8	
10	216.0	432.0	
11	218.5	436.9	
12	189.4	378.8	- Flow metered by WSC; new clock installed on recording gauge by WSC
13	185.5	370.9	
14	181.5	363.0	
15	177.5	355.1	
16	173.8	347.6	- Flows estimated as average rate of decrease/day over this period
17	169.8	339.7	
18*	166.1	332.2	
19	162.5	324.9	
20	158.6	317.2	
21	159.7	319.4	- Flow metered by WSC; clock found to be stopped on recording gauge; one stop log pulled on south bay of dam
22	170.8	341.7	
23	165.9	329.8	
24	159.6	319.2	
25	153.0	306.0	
26	148.7	297.4	
27	145.2	290.4	
28	134.6	269.3	
29	131.2	262.5	
30	131.2	262.5	
31	127.7	255.4	
		11,748.2	
Aug. 1	123.0	246.0	
2	121.0	242.0	- Pulled one log each from northern 3 bays of dam
3	150.4	300.7	
4	138.8	277.6	
5	129.0	258.1	
6	119.4	238.7	
7	115.3	230.6	
8*	105.5	211.0	- Pulled one log from south bay of dam

* denotes water quality sample collection dates.

Table 1 (continued)

Aug. 9	126.4	252.8	
10	119.0	238.0	
11	115.1	230.1	
12	105.4	210.8	- Pulled 1 log each from northern
13	176.8	353.5	three bays of dam
14	163.8	327.6	
15*	156.3	312.6	
16	140.3	280.5	
17	134.6	269.3	
18	122.8	245.5	
19	120.7	241.3	
20	113.4	226.8	
21	106.8	213.6	
22	92.0	183.9	
23	82.3	164.6	
24	75.8	151.6	
25	70.5	141.0	
26	66.1	132.2	
27	65.0	130.0	
28	58.4	116.8	
29	53.2	106.5	
30	48.2	96.4	
31	44.6	89.1	- Installed 3 logs each in all open
August Discharge =		6,719.2	bays to seal dam for winter.

Total 1983 discharges = 20,058.7 ac. ft.

Table 2. Stop log settings at The Cumberland Marshes Dam during 1983.

	Stop log elevations*							
	NORTH							SOUTH
Date	Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8
October 18/82	3.604	3.842	3.616	3.659	3.662	3.656	3.629	3.589
June 28/83	3.604	3.842	3.010	3.004	3.004	3.010	3.629	3.589
July 21/83	3.604	3.842	2.980	3.004	3.002	2.812	3.629	3.589
August 2/83	3.604	3.842	2.777	2.801	2.799	2.812	3.629	3.589
August 8/83	3.604	3.842	2.777	2.801	2.799	2.609	3.629	3.589
August 12/83	3.604	3.842	2.574	2.598	2.596	2.609	3.629	3.589
August 31/83	3.604	3.842	3.184	3.208	3.206	3.219	3.629	3.589

* Elevations expressed in meters with the Water Survey of Canada Bench Mark as 5.000 m (DU B.M. = 871.18 ft.).

Table 3. Summarized water movements at the Cumberland Marshes project between May 1 and October 31, 1983.

DRAWDOWNS:	Period	Elevations (ft.)	Days	Volume (ac.ft.)	From/To
- McGregor Lake via Birch River Marsh Centre	June 28-Aug. 31	867.40 to 864.34	63	15,772	Manitoba
- Birch River Marsh Centre	June 28-Aug. 31	866.12 to 864.00	63	2,753	Manitoba
- Birch River Marsh South	June 28-Aug. 31	866.12 to 865.36	63	1,047	Manitoba
Total discharges	June 28-Aug. 31		63	19,572	Manitoba
REFILLS:					
- Big Lake	July 28-Sept. 27	867.35 to 867.91	61	1,146	Cut Beaver
- North McGregor Lake	July 28-Sept. 27	867.25 to 867.29	61	320	Cut Beaver
- Bewley/Beaton Lakes	July 26-Sept. 27	867.39 to 867.75	63	1,130	Cut Beaver
				2,596	Cut Beaver
RETOPPING:					
- Deep Lake	July 11-July 20	875.78 to 876.13	9	503	Cut Beaver
- Bloodsucker Lake	June 29-July 25	874.80 to 875.27	26	2,028	Cut Beaver
- Highbank Lake	June 29-July 11	874.62 to 875.02	12	760	Cut Beaver
- Waterhen Lake	June 29-Sept. 27	874.09 to 874.20	89	180	Cut Beaver
- Egg Lake	July 11-Sept. 8	872.55 to 872.80	59	1,550	Cut Beaver
- West Wapisew	Sept. 5-Sept. 13	874.35 to 874.49	8	270	Cut Beaver
				5,291	Cut Beaver
EVAPORATION REPLACEMENT: Estimated to be 0.3 ft. on lakes refilled or retopped (listed above); cumulative area = 36,063 acres x 0.3' =				10,819	Cut Beaver
TOTAL CUT BEAVER DEMAND (Refills + Retoppping + Evaporation Replacement) =				18,706	Cut Beaver

Only three units were refilled after temporary drainage including Big and North McGregor Lakes and Bewley/Beaton Lake. This latter unit was refilled to pass water into North McGregor via Moosehorn Lake and was not relowered at the end of the season due to trappers' concerns about over-winter muskrat survival. The refill operation on these units was carried out during August and September when evaporation losses were highest; although flow was maintained into Big and North McGregor throughout the period inflow barely compensated for evaporation demands. Run-off and retopping will complete this refill during 1984. Total volume moved into the units during the 1983 season was estimated to be 2,596 acre feet (Table 3).

As in past years, fine-mesh screening nets were installed across the outlet between Cut Beaver Lake and downstream marsh units to prevent fish migration out of the reservoir. This operation was successful in restricting fish within the storage reservoir and will continue in 1984. Winter flows in the Dragline Channel maintained good concentrations of dissolved oxygen throughout the winter of 1982/83 and excellent fish survival was documented by test nettings in March and April, 1983. Recreational anglers utilized the reservoir throughout the open-water period and good success was reported for large pike and walleye. Local interest in fishing on Cut Beaver Lake has increased greatly in recent years and large numbers of ice fishermen are expected over the winter of 1983/84. At the end of the 1983 operating season, all leaks between stop logs at the Cumberland Marshes Dam were packed with oakum to seal this structure and prevent flow into Birch River during the upcoming winter season. It is hoped that the absence of flow at the site will cause fish to disperse prior to freeze-up thereby preventing fish die-offs below the dam this winter.

3.0 Flow sources on water quality sampling dates

(a) Dragline Channel: Inflows were high during the period between Janauary 1 and February 9 due to the structural damage discussed previously. Only one water quality sample was collected during this interval (January 10). Inflows between February 9 and June 10 varied between 20 and 30 cfs with 3 samples collected over this period (March 7, May 16 and June 6). The remaining 7 collections were taken when no detectable inflow from the Old Cannel was evident and the inlet control structure was sealed. Upcoming samples which are outstanding in the specified schedule will be taken while winter flow rates (30 cfs) prevail in the Dragline Channel inlet.

(b) Birch River below Cumberland Marshes DAm:

January 10 March 7 May 16 June 28	No internal operations underway; seepage through the Cumberland Marshes Dam from the Birch River Marsh was the only source of water at this site.
July 18 August 8 August 15	Discharge underway from the McGregor Lake, Birch Marsh Centre and Birch Marsh South drawdowns; no other contributary sources of flow over the dam during this period.
September 12 October 3 October 16	Cumberland Dam was sealed on August 31 at the end of the McGregor drawdown; contributary flow thereafter comes solely from the Birch River Marsh Centre via seepage.

4.0 Theoretical water balance

INFLOW = Storage + Discharges + Evaporation

1) Storage

		ac.ft.
Total increase in internal strorage (Refills & retopping; Table 3)	=	7,887
Total drawdown waters used internally	=	0
Storage	=	7,887

2) Discharges

Total releases to Manitoba (Table 3)		= 19,572
Total internal water released to Manitoba (Table 3)		= 19,572
Old Channel discharges to Manitoba — Discharge	=	0

3) Evaporation

Estimated to be 0.3' over 36,063 acres (see Table 3) involved in refills and retopping	= 10,819

INFLOW = 7,887 + 0 + 10,819 = 18,706 acre feet

* Cut Beaver Reservoir drawdown between June 28 and September 27 from 878.80 to 877.37 accounts for a total volume change of 22,000 acre feet from stage/storage data.

The total inflow estimate above (18,706 acre feet) combined with an estimated 0.3' evaporation loss over 12,950 acres on Cut Beaver Lake (3,885) totals 22,591 acre feet and thereby balances the total drawdown estimate of 22,000 acre feet above.

5.0 Net change in internal storage

Table 4 presents final lake elevations at the end of the 1983 operating season. Based upon change in elevations between 1982 and 1983 fall water levels, the net change in internal water storage is estimated to be + 3,718 acre feet.

Table 4. Lake elevations at the end of operations in the Cumberland Marshes project during 1982 and 1983.

Lake	Elevation (ft.) Oct. 8/82	Sept. 27/83	Variation (ft.) 1982 vs. 1983	Volume (ac.ft.)
Bewley/Beaton	867.2	867.8	+ 0.6	+ 1,860
Big	865.9	867.9	+ 2.0	+ 3,630
Birch River Marsh	865.1	864.5	- 0.6	- 750
Birch River Marsh North	865.2	865.8	+ 0.6	+ 1,650
Birch River Marsh South	865.0	865.3	+ 0.3	+ 384
Bloodsucker	874.6	875.0	+ 0.4	+ 1,680
Bog	866.2	866.9	+ 0.7	+ 1,610
Cut Beaver	877.7	877.4	- 0.3	- 3,660
Deep	875.8	875.9	+ 0.1	+ 150
Egg	872.2	872.8	+ 0.6	+ 3,420
Highbank	874.3 *	874.8	+ 0.5 *	+ 960
Junction Flats	874.6	874.6	same	no change
Junction	876.1	876.1	same	no change
McGregor	867.2	865.0	- 2.2	-12,490
North McGregor	866.7	867.3	+ 0.6	+ 1,680
Muskeg	876.8	877.0	+ 0.2	+ 84
Rat/Petabecs	866.5	867.4	+ 0.9	+ 2,290
Waterhen	874.1	874.2	+ 0.1	+ 180
East Wapisew	873.0 *	873.5	+ 0.5 *	+ 1,700
West Wapisew	874.8	874.5	- 0.3	- 660
		Net Change in internal storage =		+ 3,718 acft

* 1982 water levels revised by -1.0 ft. after topographic surveys in winter 1982-83 revealed structure elevations were in error by this factor.